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CUMBERLANDIAN MOLLUSK CONSERVATION PROGRAM

ACTIVITY 8:
Analysis of Macrofauna Factors

Office of Natural Resources and Economic Development
Tennessee Valley Authority
Knoxville, Tennessee 37902

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TENNESSEE VALLEY AUTHORITY

Office of Natural Resources and Economic Development

CUMBERLANDIAN MOLLUSK CONSERVATION PROGRAM

Activity 8:

Analysis of Macrofauna Factors

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INTRODUCTION

The Office of Management and Budget asked TVA to investigate alternatives to the Columbia Dam and Reservoir Project that could meet the water supply and flood control needs of the region and not violate the Endangered Species Act of 1973. After evaluation of several alternatives, TVA concluded that with an intensive conservation and relocation effort for endangered species, the original project proposal would be no more harmful to mussels than other practicable alternatives (TVA 1979).

Research plans were developed to examine all aspects of the life history of Conradilla caelata and of Quadrula intermedia in order to describe habitat and limnological conditions necessary to maintain reproducing populations of these mussels. The Activity 8-Macrofauna Analysis portion of this research was charged, "To determine the characteristics of fish and benthic faunal communities in designated study areas of the Duck, Clinch, Powell, and possibly other rivers in order to provide information that will assist in the analysis of molluscan habitat requirements". This report summarizes the findings of those efforts.

PROCEDURES

To characterize faunal communities in designated study areas of the Duck, Clinch, Powell, North Fork Holston, Nolichucky, Buffalo, Paint Rock and Elk Rivers and Copper Creek, 15 standardized sampling

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sites (650-foot reaches of river) were selected and sampled for mussels, benthic macroinvertebrates, and fish. Specific locations, physical, and hydrological characteristics of individual sites are detailed in a separate report (Ostrowski and Speaks, 1983).

Mollusks

A stratified random sampling scheme was used to estimate mussel abundance (Cochran 1963) during the period from May through October 1981. Estimates were made in both relative (number/m²) and absolute (population estimate) terms. Total population estimates for each mussel species occurring at a site were calculated by expanding the number of each mussel species collected from all 1/4 m² quadrat samples to total area of the site. Because a random sampling scheme was used, each site was surveyed by field crews and the water's edge was located relative to a designated reference point established above the high water line and at the downstream end of the site. A baseline was extended upstream from this reference point. Stakes were set at 50-foot intervals along the baseline with corresponding stakes set on the opposite side of the stream.

Maps were prepared for each site with a grid (developed from reference point and baseline) of cells (five feet square) superimposed on the map. Each site was stratified into 10,000 square foot areas which were divided into 400 cells. Using a computerized random number generator program, sixteen cells within each stratum were randomly selected for search, with two replicate samples (1/4 m² quadrat) taken within each cell.

The cells to be sampled were located using anchor stakes set at the water's edge and in line with each pair of 50-foot interval base-line stakes (Figure 1). Cables (marked at 5-foot intervals) strung across the stream between two pairs of corresponding stakes, were used to locate sample cells across the width of the rivers and a tape measure (50-foot) was used to locate the designated cells along the length of stream between the two cables.

A snorkeler or diver (depending upon depth of water) randomly placed a $1/4 \text{ m}^2$ quadrat sampler on the substrate within the area of the sample cell. The sample depth was measured, and substrate characterized (i.e., clay, sand, sand and gravel, cobble, etc.). All mussels within the confines of the quadrat were collected and placed in a nylon mesh collection bag. After the search was completed, mussels were sorted by species, enumerated, then returned to the substrate. A second sample, collected in the same manner, was then taken in each sample cell after moving the quadrat one-half meter toward mid-stream from the initial sample.

A two-way cluster analysis of the distribution of mussels in standard sampling sites was used to examine the relationship of species within sample sites. The Jaccard coefficient of association was used to cluster sample sites and species (Jaccard 1908): $s(j) = a/(a + b + c)$; where, a is the number of species occurring in both sample areas, b is the number of species occurring in site 1, but not site 2, and c is the number of species in site 2, but not site 1. The Jaccard coefficients were then subjected to cluster analysis using the unweighted pair-group method (Sneath and Sokal 1973).

Benthic Macroinvertebrates

The 15 sites were sampled for benthic macro-invertebrates on a quarterly basis from July 1980 to May 1981. Both qualitative and quantitative samples were collected.

Quantitative samples were taken using an unmodified Surber square-foot sampler in shoal and riffle areas. At each site, four approximately evenly spaced samples were collected in a transect across the shoal. Qualitative samples were collected during the same field trips using D-nets, Needham scrapers, and handpicking. During qualitative sampling, an attempt was made to sample all available habitat types, including muck, vegetation, and debris. All samples were preserved in 10 percent formalin and sent to the laboratory where they were sorted and identified to the lowest possible taxon.

Fish

Fish were collected monthly during 1981 at each site during the suspected glochidia release period for Cumberlandian mollusks (May, June, and July). Three assessment techniques were used--snorkeling, haul seining, and backpack electrofishing.

Both quantitative and qualitative samples were collected in each sample area. Measured transects were systematically sampled using snorkeling and backpack electrofishing gear. Transects were established over each habitat type (i.e. sand and gravel, rubble, vegetation, and/or bedrock) at the various sample locations. Backpack electrofishing and haul seining techniques were also used to collect random samples throughout each study area.

Systematic snorkel transects covering an area 4.9 x 15.2 m were sampled by four divers. The divers swam abreast in a downstream direction driving fish into a 6 m seine held stationary in the river. A 7.6 m anchored rope was used to establish the length of each transect. To maintain a standard interval and an overall transect width of 4.9 m, each diver held a 1.1 m fiberglass pole connected to the adjacent diver's pole by four links of chain. Bumping these poles along the bottom also served to drive fish downstream into the seine. Snorkel transects were conducted during daylight hours only. Six transects were sampled in each habitat type. The mean number of each fish species collected per transect was used to estimate its relative abundance at each location.

Electrofishing collections were made using a transect technique similar to that used during snorkel sampling. The electroshocker was used to drive the fish into a stationary 6 m seine. As before, transect length was determined using a 7.6 m anchored rope and transect width was determined by seine length (4.9 m allowing for positioning of the seine to form a "bag"). Six transects were sampled over each habitat type at the 15 study reaches. The mean number of each fish species collected per electrofishing transect was used to estimate relative abundance. Backpack electrofishing samples were collected during both day and night periods.

To add to the qualitative data base, day and night random seine hauls were made throughout the sampling area using a standard 6 m seine (6 mm mesh size) and/or a 9.1 m bag seine (6 mm mesh size). Additional qualitative samples were collected using the backpack electroshocker and longhandled dip nets to collect fish near the shoreline and around obstructions such as logs, tree roots, etc.

The fish assemblage within the different rivers was examined to determine the presence/absence of a potential host fish and how the relative abundance of specific fish populations correlated with the presence of mussels in a study reach. The total number of fish of a particular species collected at a study site was divided by the total fish (all species combined) collected at that site. Resulting proportions were then ranked from most abundant to least abundant by sample site. Since adequate numbers of host fish must be present to perpetuate mussel populations, only those species comprising a 0.01 ratio (one percent) of the total fish assemblage for each study site were used in the rankings. These species were ranked in decreasing order of abundance for all study reaches combined, for those reaches with C. caelata and Q. intermedia populations, and for those reaches that did not contain the two endangered mussels.

Most fish collected by the various techniques were identified, counted, and returned alive to the stream. Voucher specimens of each species and specimens of questionable identity were preserved in 10 percent formalin and taken to the laboratory for positive identification.

RESULTS

Mollusks

A total of 43 species of freshwater mussels was collected from all sites (Table 1). Of these, 17 species were considered as "Cumberlandian", 5 of which were listed as Endangered by the U.S. Fish

and Wildlife Service. The total number of mussels collected, and dominant substrate is provided for each sample in the 15 study reaches (Appendix: Figures A-1 through A-15).

Species composition varied greatly among stations within the same river. For example, 33 mussel species were collected from Clinch River Mile (CRM) 189.5 while only 9 species were found at CRM 227.4 (Table 1). In the Duck River, 24 species were collected from Duck River Mile (DRM) 179.1 while only 5 species were observed at DRM 159.4, 3 at DRM 202.2, and 1 at DRM 243.1. The cold water discharged through Normandy Dam, previous pollution mishaps, and Lillard's Mill Dam (prevents fish migration and thus mussel recolonization) appear to have had significant impacts on the mussel fauna from DRM 248.6 to DRM 179.3 (just above Lillard's Mill Dam).

Likewise, mussel abundances varied considerably among rivers (table 2). The Clinch River at CRM 189.5 had the largest estimated number of mussels (108,343) followed by the Duck River at DRM 179.1 (75,339), and the Powell River at PRM 99.9 (54,780). Sites supporting the largest estimated populations of Cumberlandian species include: Clinch River--CRM 189.5 (43,266), Powell River--PRM 99.9 (35,988), and North Fork Holston River--NFHRM 85.2 (22,786). Species specific abundance information is presented in the Appendix (Table A-1).

Population estimates were based on randomized sampling within strata where each stratum was determined to be a transect of the river reach that contained 10,000 square feet. Since the width of the 15 study reaches varied considerably, there may be some bias introduced since substrate, flow, currents, and channel morphology could influence the populations. With all samples chosen randomly it was decided that

estimates of abundance (number/m²) would allow a realistic approach for comparison of mussel densities at the sites. These data (Table 3) indicate that the Powell River site at PRM 99.9 has the greatest mussel density per unit area (4.06 mussels/m²) followed by the Clinch River at CRM 189.5 (3.81 mussels/m²), the Powell River at PRM 117.4 (3.62 mussels/m²), and the Duck River at DRM 179.1 (3.46 mussels/m²). Individual species abundance estimates are presented in the Appendix (Table A-2).

The cluster analysis of sample sites revealed three major associations based on within-group average Jaccard coefficients. The standard sampling site association complex I included all Powell and Clinch River sites in addition to the Duck River at DRM 179.1 and the Nolichucky River site (Figure 2). Of these, faunal affinity was highest for the two Powell River sites, the Clinch River at CRM 189.5, and the Duck River at DRM 179.1.

The second association group (II) included both North Fork Holston River sites, the Paint Rock River site, and the Copper Creek site, all in relatively small rivers. The third association group (III) included the remaining three Duck River sites and the Elk River site. The Buffalo River site had low faunal affinity with all other sites.

Of the 43 mussel species presented in Figure 2, 40 were represented in site association complex I, however only two species (Amblema costata and Proptera alata) were present at all 6 locations in the complex. In complex II there were 18 species present with 4 species (Fusconaia barnesiana, Lampsilis fasciola, Pleurobema oviforme, Villosa nebulosa) found at each of the 4 sample areas, while site association complex III had only 11 species present with none occurring throughout

the 5 sites. The decreasing numbers of species in site association groups I through III, coupled with decreasing instances of individual species occurrence at sites within groups (I-121, II-38, III-20) suggests something is now or has in the past affected the quality of sites in complexes II and III.

Cluster analysis of species revealed four major associations (Figure 2). There are 10 species included in the association group with C. caelata and 11 are grouped with Q. intermedia.

With the exception of one site (DRM 179.1) the members of species association group I are missing from site association complex I and show scattered distribution patterns in site complexes II and III (Figure 2). In general these species show a poor level of correlation with each other and with the other species association groups. Taxa in species association group II are eurytypic, widely distributed geographically and are found in all three site association complexes. Mussels in species association group III are primarily found in site association complex I with two exceptions (Ptychobranchus subtentum and Fusconaia cuneolus, both Cumberlandian species associated with medium to small rivers) found in site complex II. Species group IV is characteristic of two sites, CRM 189.5 and DRM 179.1 in site association complex I. Based on abundance and species present these two locations represent optimal mussel habitat. The two group IV species that occur in site complex III (Quadrula pustulosa and Lastena lata) are relatively widespread and can accommodate considerable silt in their habitat.

In summary, (eurytypic) mussel species (species association group II) are more than twice as prevalent in site association complex I

than in complex III. Species groups III and IV are found almost exclusively in site complex I, whereas species association group I was poorly correlated either with other mussel species or site association groups (Figure 2).

The 11 taxa in species association group III (including Q. intermedia) and the 10 taxa in species group IV (including C. caelata) were closely linked with the site complex I (figure 2). Along with the known locations of the species of concern, site complex I contained one potential transplant site (NRM 27.8) on the Nolichucky River. The conspicuous absence of molluscan species associated with C. caelata and Q. intermedia from sites other than site complex I suggests habitats included in site associations II and II either were not adequate for the assemblages or have been affected by physical/chemical components which excluded these species.

Benthic Macroinvertebrates

Although non-molluscan benthic fauna communities at the 15 sampled river reaches can all be described as diverse, apparently healthy communities, there are significant differences among them. Results of cluster analysis based on Jaccard coefficients (Figure 3) indicate two sample site association groups if one uses a criterion of 0.4 similarity (the median value). Complex I includes all sites on the Clinch, Powell, North Fork Holston, Nolichucky, and Copper Creek. These are all tributaries of the upper Tennessee and are located in eastern Tennessee or southwest Virginia. Complex II includes the Duck River sites with the exception of mile 243.1. Four sites, DRM 243.1, BRM 79.9, ERM 91.4, and PRRM 60.0 did not have 40% similarity with either complex.

A total of 166 taxa were collected in Surber samples from the 15 study reaches during four quarters of sampling (Appendix Table A-3). Qualitative sampling added an additional 35 taxa. Species occurrence is shown in Appendix Table A-4. Coefficients of species similarity (Table 4) show that among sites sampled, none of the communities are very similar to Lillard's Mill. The Hall Mill site on the Duck River most closely resembles the Lillard's Mill site, the two communities sharing approximately 46% of the taxa from those sites in common. Other sites shared 43% or fewer of their taxa in common with the Lillard's Mill community. Relative abundance of taxa at each site are shown in Appendix Tables A-5 and A-6.

Diversity indices (Table 5) were lowest at the Elk River ($\bar{H} = 3.35$), Duck River Mile 243.1 ($\bar{H} = 3.50$), Powell River Mile 117.4 ($\bar{H} = 3.17$), North Fork Holston River Mile 6.2 ($\bar{H} = 3.45$), and Nolichucky River Mile 27.8 ($\bar{H} = 3.43$). Standing crops of bottom fauna (mean numbers of organisms per square-foot) and numbers of taxa (Table 5) were lowest in the Elk and the four Duck River sites. Standing crops were greater and mean numbers of taxa higher in the Clinch, Powell, North Fork Holston, Nolichucky, and Paint Rock Rivers and in Copper Creek.

Fish

A total of 111 fish species was collected from nine streams encompassing the 15 standard sampling sites (Table 6). Of these, 34 species were common to sites supporting populations of either C. caelata or Q. intermedia. These species will be referred to as "overlap" fish species (Table 7).

Relative abundance of each overlap species fluctuated not only

among rivers but also among stations in the same river (Table 8). Abundance of certain species also fluctuated from year to year. Comparison of abundance estimates for Etheostoma zonale (known fish host for C. caelata) from sites sampled during Activity 2 and Activity 8 (1979, 1980, and 1981 mussel glochidia release periods) reveal abundance fluctuated considerably at two of the four sites sampled during both surveys (Figure 4). Thus, consideration of abundance of a host fish species at a particular site based on only one season of data may lead to an inappropriate selection of transplant sites.

Some overlap species (i.e., Lepisosteus osseus, Dorosoma cepedianum, Ictalurus punctatus, Ambloplites rupestris, Lepomis megalotis, Micropterus dolomieu, and M. punctulatus) prefer habitat types other than those quantitatively sampled. Therefore, overall abundance of these species may not be accurately reflected by relative abundance estimates. Abundances of overlap species are generally described for each study site in Table 9 by categorizing species according to total number collected (both quantitative and qualitative samples).

The percent of overlap species for C. caelata found at sampling sites without C. caelata populations indicate that the largest number of C. caelata overlap species (Table 10) were collected from the DRM 159.4 and PRM 117.4 sites. For Q. intermedia, the DRM 159.4 and the CRM 189.5 sites support the highest number of overlap species (Table 11).

In an analysis performed independently of the overlap species test, lists of total occurrence over all sample periods, by fish species

for each site, were compiled and ranked from most abundant to least abundant. All those species that comprised at least one percent of the total number of fish for each site were then analyzed by rank to establish the most common fish species present in the 15 study reaches. Because of variation between reaches and between rivers, 64 species were used in the analysis. Overall there was a mean of 19 (S.D. = 3) fish species encompassing 91.6 (S.D. = 3.4) percent of the total assemblage per reach. Since the fish data were collected during portions of three or four years for most study reaches, they were assumed to be representative of fish community through time.

After ranking fish in descending order of abundance by study reach, those areas that had populations of Cumberlandian mussels were compared with reaches where the group was absent. The 25 most abundant fish species ($19 + 2$ S.D.) throughout all samples, along with their rank among river systems with (Duck, Powell, and Clinch) and without Cumberlandian mollusks are presented in table 12.

With the exception of Etheostoma simoterum (Tennessee snubnose darter) all of the ranked potential fish host species are included in the overlap species (Table 7). In each case those fish noted in Table 7 and not included in Table 12 were present only rarely (less than 10 total specimens collected) or were uncommon (less than 100 total specimens) at all sites. The high degree of concordance between the two

SUMMARY

This study provides information that may be critical to the continued survival of mussels, more particularly the endangered species C. caelata and Q. intermedia in several rivers throughout the region. The biotic components of several river reaches that have populations of these endangered species (DRM 179.1, PRM 117.4, PRM 99.2, and CRM 189.5) were examined to determine what biotic attributes were different from those study reaches that did not have these mussels. It was postulated that these comparisons would identify sites to which C. caelata and/or Q. intermedia could be transplanted with a high probability that they would survive and reproduce, hence, assuring continuation of the species. Since the two species of interest were part of the Cumberlandian Mollusk Complex (Ortmann 1924), the presence of other species in this same group was considered to be an important factor for assessing the suitability of recolonization areas outside the Columbia Dam and Reservoir site.

The benthic macroinvertebrate communities throughout the study reaches were quite similar with respect to diversity (median $\bar{H} = 3.47$, range; 3.17-4.29), however the Elk River site (ERM 91.4) and all of the Duck River sites (DRM 159.4, 179.1, 202.2, and 243.1) had significantly fewer bottom fauna species and numbers than did the other study reaches. Jaccard coefficients of similarity between sites ranged from 0.23 (ERM 91.4) to 0.46 (DRM 202.2) indicating considerable variability among the bottom fauna throughout the region. In all cases the quantity and quality of the benthos would be considered adequate to sustain those consumers, in this case fish, that are necessary to assure continuation of the mussel community.

The 25 potential host fish represent those fish species present in adequate numbers to provide for completion of the life cycle for Cumberlandian mollusks. With the exception of Noturus eleutherus (mountain madtom) and Pimephales notatus (bluntnose minnow), the assemblages present in those streams without C. caelata and Q. intermedia were quite similar to the fishes in the Duck, Powell, and Clinch Rivers where the endangered mussels are at present surviving.

If fish other than Etheostoma zonale (banded darter) are determined to be acceptable hosts for either C. caelata or Q. intermedia and are a part of the list in Table 12, then there will probably be adequate numbers at each potential transplant site to accomplish reproduction.

Since the molluscan assemblage varies considerably from study reach to study reach (Table 2) there probably exists some factor that either mitigates for or against the presence of mussels in general and Cumberlandian forms in specific. The presence of viable populations of C. caelata and Q. intermedia in the Duck and Clinch-Powell River systems suggests both species were more widespread than at present. During this study we have determined that the benthic macrofauna at all sites is adequate, and supports a fish assemblage of considerable diversity and abundance, hence it is probable that adequate fish hosts are available to accommodate a complex mussel fauna.

The two mussel species of concern are part of the Cumberlandian mussel complex which showed considerable variability between reaches (Table 2). The total number of Cumberlandian forms was used to help classify study reaches from most to least acceptable for the species of interest. In those cases where the same number of

Cumberlandian forms were present, the total number of mussel species was used to differentiate between reaches. Table 13 shows the classification of the study reaches. Since C. caelata is the species of primary concern, the sites are ranked for this species, hence Lillards Mill (CRM 179.1) is displaced upward in the Q. intermedia column.

Numerical ranking shows that based on equal weighting for all parameters, the Kyles Ford (CRM 189.5) and Fletcher Ford (PRM 117.4) sites ranked higher than Lillards Mill (CRM 179.5) notwithstanding the fact that Lillards Mill has a much larger population of C. caelata. This suggests that based on these investigations, the Clinch-Powell system would constitute an ideal relocation area. Conversely, the Lillards Mill site would be an acceptable recolonization area for Q. intermedia. However, in order to evaluate relative success of relocation, the mussels must be introduced into areas with proper habitat requirements, but where they were not presently living.

For those sample sites where neither C. caelata nor Q. intermedia were present, the simultaneous consideration of several biotic parameters produced some apparent incongruities. For example, the relatively low ranking of the Nolichucky River site (tied for last place among 15 sites) in spite of its inclusion in the optimal site group (site complex I, figure 2) was due to the absence of Cumberlandian mussel forms and the relatively low percentage of overlap species within the fish assemblage. However, as this information is combined with other attributes of the several potential transplant sites, a hierarchy of preferred sites should develop. It is important to remember that the potential transplant sites were not selected randomly, but were judged the 'best' of several areas in their particular drainages.

Table 1. Mussel species collected at the fifteen standard sampling sites, 1981.

Species	Status	ERM 91.4	CRM 189.5	CRM 227.4	DRM 159.4	DRM 179.1	DRM 202.2	DRM 243.1	BRM 79.9	PRM 99.2	PRM 117.4	NFHRM 6.2	NFHRM 85.2	NRM 27.8	PRRM 60.0	CCRM 1.9
<u>Cumberlandia</u> <u>monodonta</u>			+													
<u>Amblema</u> <u>costata</u>			+	+		+				+	+	+		+		.
<u>Fusconaia</u> <u>barnesiana</u>	C	+	+	+		+				+	+	+	+		+	+
<u>Fusconaia</u> <u>cuneolus</u>	CE		+								+					+
<u>Fusconaia</u> <u>subrotunda</u>			+							+	+					
<u>Fusconaia</u> <u>edgariana</u>	CE												+			+
<u>Quadrula</u> <u>cylindrica</u>			+			+					+					
<u>Quadrula</u> <u>intermedia</u>	CE									+	+					
<u>Quadrula</u> <u>pustulosa</u>		+	+			+										
<u>Tritogonia</u> <u>verrucosa</u>						+										
<u>Megaloniaias</u> <u>gigantea</u>						+										
<u>Cycloniaias</u> <u>tuberculata</u>		+	+		+	+	+			+	+			+		
<u>Elliptio</u> <u>crassidens</u>			+													
<u>Elliptio</u> <u>dilatatus</u>		+	+			+				+	+			+		+
<u>Lastena</u> <u>lata</u>		+	+													
<u>Lexingtonia</u> <u>dolabelloides</u>	C	+			+	+	+	+								
<u>Plethobasus</u> <u>cyphus</u>			+								+					
FAEB 19(v)																

Species	Status	ERM 91.4	CRM 189.5	CRM 227.4	DRM 159.4	DRM 179.1	DRM 202.2	DRM 243.1	BRM 79.9	PRM 99.2	PRM 117.4	NFHRM 6.2	NFHRM 85.2	NRM 27.8	PFRM 60.0	CCRM 1.9
<u>Pleurobema</u>																
<u>cordatum</u>			+			+										
<u>Pleurobema</u>																
<u>oviforme</u>	C		+			+				+		+	+		+	+
<u>Alasmidonta</u>																
<u>marginata</u>			+													
<u>Lasmigona</u>																
<u>costata</u>			+	+		+				+	+					
<u>Actinonaias</u>																
<u>carinata</u>			+	+	+					+	+			+		
<u>Actinonaias</u>																
<u>pectorosa</u>	C	+	+	+		+				+	+		+			
<u>Carunculina</u>																
<u>moesta</u>	C														+	
<u>Dysnomia</u>																
<u>breyidens</u>	C		+							+	+					
<u>Dysnomia</u>																
<u>capsaeformis</u>	C		+			+				+	+					+
<u>Dysnomia</u>																
<u>triquetra</u>			+							+	+					
<u>Lampsilis</u>																
<u>fasciola</u>		+	+		+	+	+			+	+	+	+	+	+	+
<u>Lampsilis ovata</u>			+			+				+	+	+		+	+	
<u>Leptodea</u>																
<u>fragilis</u>						+				+	+					
<u>Ligumia recta</u>			+	+						+	+					
<u>Medionidus</u>																
<u>conradious</u>	C	+	+		+					+	+		+		+	+
<u>Obovaria</u>																
<u>subrotunda</u>		+				+									+	
<u>Proptera alata</u>			+	+		+			+	+	+			+		
<u>Truncilla</u>																
<u>truncata</u>			+			+										
<u>Villosa nemulosa</u>	C		+			+					+	+	+		+	+
<u>Villosa vanuxemi</u>	C		+	+		+						+	+		+	

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Species	Status	ERM 91.4	CRM 189.5	CRM 227.4	DRM 159.4	DRM 179.1	DRM 202.2	DRM 243.1	BRM 79.9	PRM 99.2	PRM 117.4	NFHRM 6.2	NFHRM 85.2	NRM 27.8	PRRM 60.0	CCRM 1.9
<u>Villosa</u>																
<u>perpurpurea</u>	C															+
<u>Cyprogenia</u>																
<u>irrorata</u>			+	+												
<u>Dromus dromus</u>	CE									+	+					
<u>Ptychobranhus</u>																
<u>fasciolaris</u>			+			+				+	+		+	+	+	
<u>Ptychobranhus</u>																
<u>subtentum</u>	C		+							+	+		+			
<u>Conradilla caelata</u>	CE		+			+										

C=Cumberlandian species.

CE=Endangered species.

Table 2. Population estimates^{*} of mussels (all species and Cumberlandian species only) at each of the standard sampling sites in 1981.

River	Site	Overall	Cumberlandian
Clinch	CRM 189.5	108,343	43,266
Duck	DRM 179.1	75,339	13,203
Powell	PRM 99.9	54,780	35,988
Powell	PRM 117.4	34,974	20,161
North Fork Holston	NFHRM 85.2	24,068	22,786
North Fork Holston	NFHRM 6.2	8,317	1,458
Copper Creek	CCRM 1.9	6,089	5,073
Paint Rock	PRRM 60.0	4,820	3,811
Elk	ERM 91.4	3,971	1,898
Clinch	CRM 227.4	1,921	530
Nolichucky	NRM 27.8	1,559	0
Duck	DRM 159.4	1,030	232
Duck	DRM 202.2	464	232
Buffalo	BRM 79.9	232	0
Duck	DRM 243.1	116	116

^{*} Estimated Numbers of Mussels in each 650 foot reach of river.

Table 3. Relative abundance estimates, for mussels at the 15 sampling sites, 1981.

River	Site	Relative Abundance (No./m ²)
Powell	PRM 99.2	4.06
Clinch	CRM 189.5	3.81
Powell	PRM 117.4	3.62
Duck	DRM 179.1	3.46
North Fork Holston	NFHRM 85.2	2.45
Copper Creek	CCRM 1.9	0.95
Paint Rock	PRRM 60.0	0.81
North Fork Holston	NFHRM 6.2	0.37
Elk	ERM 91.4	0.24
Nolichucky	NRM 27.8	0.14
Clinch	CRM 227.4	0.09
Duck	DRM 159.4	0.08
Duck	DRM 202.2	0.04
Buffalo	BRM 79.9	0.02
Duck	DRM 243.1	0.01

Table 4. Coefficients of similarity of bottom fauna communities between Lillard Mill (DRM, 179.1) and other standard sampling sites.

River	Site	Similarity Coefficient
Duck	DRM 202.2	0.46
Duck	DRM 159.4	0.43
North Fork Holston	NFHRM 6.2	0.36
Buffalo	BRM 79.9	0.33
Clinch	CRM 227.4	0.32
Powell	PRM 117.4	0.30
Duck	DRM 243.1	0.29
Nolichucky	NRM 27.8	0.29
Clinch	CRM 189.5	0.29
Powell	PRM 99.2	0.27
Copper Creek	CCRM 1.9	0.26
Paint Rock	PRRM 60.0	0.25
North Fork Holston	NFHRM 85.2	0.24
Elk	ERM 91.4	0.23

Table 5. Diversity ($\bar{H}$), mean number and taxa of bottom faunal organisms per Surber square-foot sample $\pm$ standard deviation at each of 15 standard sampling sites.

Sample Site	Diversity Index ($\bar{H}$)	Mean Number of Taxa/Sample	Mean Number per ft ²
ERM 91.4	3.35	6.6 $\pm$ 3.5	24.2 $\pm$ 15.6
CRM 189.5	4.29	15.6 $\pm$ 3.6	123.8 $\pm$ 77.7
CRM 227.4	4.00	17.7 $\pm$ 6.8	297.1 $\pm$ 436.0
DRM 159.4	4.04	10.0 $\pm$ 5.2	46.8 $\pm$ 29.6
DRM 179.1	3.98	9.6 $\pm$ 5.3	53.9 $\pm$ 48.7
DRM 202.2	4.14	10.9 $\pm$ 5.4	42.1 $\pm$ 25.9
DRM 243.1	3.50	7.9 $\pm$ 3.2	41.5 $\pm$ 53.7
BRM 79.9	3.73	13.0 $\pm$ 3.7	65.5 $\pm$ 52.0
PRM 99.2	3.87	13.1 $\pm$ 5.1	178.2 $\pm$ 172.0
PRM 117.4	3.17	13.2 $\pm$ 2.7	154.4 $\pm$ 147.7
NFHRM 6.2	3.45	18.6 $\pm$ 5.2	241.8 $\pm$ 389.3
NFHRM 85.2	4.27	18.2 $\pm$ 4.7	168.5 $\pm$ 85.3
NRM 27.8	3.43	13.7 $\pm$ 3.4	290.2 $\pm$ 309.8
PRRM 60.0	4.03	17.1 $\pm$ 6.2	104.2 $\pm$ 145.3
CCRM 1.9	3.97	16.2 $\pm$ 4.1	137.2 $\pm$ 76.8

Table 6. Fish species collected from nine streams sampled during 1981 CMCP Activity 8.

Species	Buffalo River	Clinch River	Copper Creek	Duck River	Elk River	Nolichucky River	NF Holston River	Paint Rock River	Powell River
<u>Ichthyomyzon bdellium</u>		+	+	+	+	+	+		+
<u>I. castaneus</u>								+	
<u>Polyodon spathula</u>									+
<u>Lepisosteus oculatus</u>				+					
<u>L. osseus</u>		+	+	+		+		+	+
<u>Dorosoma cepedianum</u>	+	+	+	+				+	+
<u>D. petenense</u>		+							+
<u>Salmo gairdneri</u>				+	+				
<u>Esox masquinongy</u>		+							
<u>Camptostoma anomalum</u>	+	+	+	+	+	+	+	+	+
<u>Clinostomus funduloides</u>	+			+					
<u>Cyprinus carpio</u>				+	+				
<u>Hybopsis amblops</u>	+	+	+	+	+	+	+	+	+
<u>H. cahni</u>		+							+
<u>H. dissimilis</u>	+	+	+	+	+		+	+	+
<u>H. insignis</u>	+	+	+	+		+	+	+	+
<u>H. monacha</u>							+		
<u>Nocomis effusus</u>				+					
<u>N. micropogon</u>	+	+	+		+	+	+		+
<u>Notropis ardens</u>					+				
<u>N. ariomus</u>	+	+		+	+		+		+
<u>N. atherinoides</u>		+							
<u>N. boops</u>	+			+				+	
<u>N. coccogenis</u>		+	+				+		+
<u>N. cornutus</u>	+	+	+	+	+	+	+	+	+
<u>N. galacturus</u>	+	+	+	+	+		+	+	+
<u>N. leuciodus</u>	+	+	+			+	+	+	+
<u>N. lirus</u>	+		+	+				+	

Table 6 (Continued)

Species	Buffalo River	Clinch River	Copper Creek	Duck River	Elk River	Nolichucky River	NF Holston River	Paint Rock River	Powell River
<u>Notropis photogenis</u>	+	+	+	+	+	+	+		+
<u>N. rubellus</u>	+	+	+	+	+	+	+		+
<u>N. spilopterus</u>	+	+	+	+	+	+	+	+	+
<u>N. volucellus</u>	+	+	+		+	+			+
<u>N. whipplei</u>		+		+					
<u>N. telescopus</u>	+	+	+	+	+	+	+	+	+
<u>N. (undescribed)</u>		+		+	+		+	+	+
<u>N. (undescribed)</u>								+	
<u>N. heterolepis</u>				+					
<u>Phenacobius uranops</u>	+	+	+	+	+	+	+		+
<u>P. crassilabrum</u>						+			
<u>Pimephales notatus</u>	+	+	+	+	+			+	+
<u>P. vigilax</u>	+			+			+		
<u>Rhinichthys atratulus</u>		+							+
<u>Semotilus atromaculatus</u>	+	+		+	+				
<u>Hypentelium nigricans</u>	+	+	+	+	+	+	+	+	+
<u>Ictiobus bubalus</u>						+			
<u>I. niger</u>					+				
<u>Minytrema melanops</u>	+			+					
<u>Moxostoma macrolepidotum</u>	+	+		+	+	+		+	
<u>M. carinatum</u>	+	+		+				+	+
<u>M. duquesnei</u>	+	+	+	+	+	+	+	+	+
<u>M. erythrurum</u>	+	+	+	+	+	+	+	+	+
<u>Ictalurus natalis</u>	+	+		+		+	+	+	+
<u>I. punctatus</u>	+	+	+	+	+	+	+	+	+
<u>Noturus eleutherus</u>		+	+	+			+		+
<u>N. exilis</u>	+								

Table 6 (Continued)

Species	Buffalo River	Clinch River	Copper Creek	Duck River	Elk River	Nolichucky River	NF Holston River	Paint Rock River	Powell River
<u>Noturus flavus</u>			+	+					
<u>N. miurus</u>				+					
<u>N. flavipinnis</u>			+						
<u>N. insignis</u>							+		
<u>N. elegans</u>				+				+	
<u>Pylodictis olivaris</u>	+	+		+		+			+
<u>Anguilla rostrata</u>								+	
<u>Fundulus catenatus</u>	+	+		+				+	
<u>F. notatus</u>				+					
<u>F. olivaceus</u>	+			+				+	
<u>Gambusia affinis</u>				+	+	+		+	
<u>Morone chrysops</u>								+	+
<u>Ambloplites rupestris</u>	+	+	+	+	+		+	+	+
<u>Lepomis gulosus</u>	+							+	
<u>L. auritus</u>		+		+		+	+		
<u>L. cyanellus</u>	+			+	+				
<u>L. macrochirus</u>	+	+	+	+	+	+	+	+	
<u>L. megalotis</u>	+	+	+	+	+		+	+	+
<u>Micropterus dolomieu</u>	+	+	+	+		+	+	+	+
<u>M. punctulatus</u>	+	+		+		+	+	+	+
<u>M. salmoides</u>	+			+			+		
<u>Pomoxis annularis</u>		+							+
<u>P. nigromaculatus</u>		+		+					
<u>Ammocrypta clara</u>									+
<u>Etheostoma acuticeps</u>						+			
<u>E. blennioides</u>	+	+	+	+	+	+	+	+	+
<u>E. blennius</u>	+			+	+				
<u>E. caeruleum</u>	+			+	+			+	
<u>E. camurum</u>		+		+		+	+		+

Table 6 (Continued)

Species	Buffalo River	Clinch River	Copper Creek	Duck River	Elk River	Nolichucky River	NF Holston River	Paint Rock River	Powell River
<u>Etheostoma cinereum</u>					+				
<u>E. duryi</u>				+					
<u>E. flabellare</u>	+			+	+			+	
<u>E. jessiae</u>		+	+		+	+		+	+
<u>E. kennicotti</u>	+			+				+	
<u>E. luteovinctum</u>				+					
<u>E. maculatum</u>		+	+			+	+		+
<u>E. nigrum</u>								+	
<u>E. rufilineatum</u>	+	+	+	+	+	+	+	+	+
<u>E. simoterum</u>	+	+	+	+	+	+	+	+	+
<u>E. squamiceps</u>				+					
<u>E. stigmaeum</u>	+			+					
<u>E. tippecanoe</u>		+		+					
<u>E. zonale</u>	+	+	+	+	+	+	+	+	+
<u>E. (undescribed)</u>			+						
<u>E. aquali</u>	+			+					
<u>E. (undescribed)</u>				+	+				
<u>Percina aurantiaca</u>		+	+				+		+
<u>P. caprodes</u>	+	+	+	+	+		+	+	+
<u>P. copelandi</u>		+							+
<u>P. burtoni</u>	+		+						
<u>P. evides</u>	+	+	+		+	+	+		+
<u>P. phoxocephala</u>				+					
<u>P. sciera</u>	+	+	+	+				+	+
<u>Aplodinotus grunniens</u>				+				+	
<u>Cottus carolinae</u>	+	+		+	+	+	+	+	+
<u>Labidesthes sicculus</u>		+		+					

Table 7. Overlap fish species collected at the sites where Conradilla caelata and Quadrula intermedia were present.

Fish Species	<u>Quadrula</u> <u>intermedia</u>	<u>Conradilla</u> <u>caelata</u>
<u>Lepisosteus osseus</u>	+	+
<u>Dorosoma cepedianum</u>	+	+
<u>Campostoma anomalum</u>	+	+
<u>Hybopsis dissimilis</u>	+	+
<u>H. insignis</u>	+	
<u>H. amblops</u>	+	+
<u>Notropis ariommus</u>	+	+
<u>N. cornutus</u>	+	+
<u>N. galacturus</u>	+	+
<u>N. photogenis</u>	+	+
<u>N. rubellus</u>	+	+
<u>N. spilopterus</u>	+	+
<u>N. telescopus</u>	+	+
<u>N. (undescribed)</u>	+	+
<u>Phenacobius uranops</u>	+	+
<u>Pimephales notatus</u>	+	+
<u>Hypentelium nigricans</u>	+	+
<u>Moxostoma duquesnei</u>	+	+
<u>M. erythrurum</u>	+	+
<u>Ictalurus punctatus</u>		+
<u>Noturus eleutherus</u>	+	+
<u>Ambloplites rupestris</u>	+	+
<u>Lepomis megalotis</u>	+	+
<u>Micropterus dolomieu</u>	+	+
<u>M. punctulatus</u>	+	+
<u>Etheostoma blennioides</u>	+	+
<u>E. camurum</u>	+	+
<u>E. rufilineatum</u>	+	+
<u>E. zonale</u>	+	+
<u>E. stigmaeum</u> or <u>jessiae</u> *	+	+
<u>E. maculatum</u> or <u>aquali</u> *	+	+
<u>Percina caprodes</u>	+	+
<u>P. sciera</u>	+	+
<u>Cottus carolinae</u>	+	+

*Similarities in systematics and preferred habitat merit considering the two species as a species group.

Table 8. Relative abundance estimates (mean number per transect) of overlap fish species at the 15 standard sampling sites. Values of 0.00 indicate that a species was collected by qualitative sampling only.

Species	Duck RM 159.4	Duck RM 179.2	Duck RM 202.2	Duck RM 243.1	Clinch RM 189.5	Clinch RM 227.4	Copper Cr. RM 1.9	Powell RM 99.2
<u>Lepisosteus osseus</u>	0.02	0.00	0.00		0.01	0.00	0.00	0.00
<u>Dorosoma cepedianum</u>	0.00	0.02	0.01		0.02	0.04	0.04	0.00
<u>Campostoma anomalum</u>	0.19	1.33	0.02	2.07	0.28	4.11	0.76	0.44
<u>Hybopsis amblops</u>	0.07	0.22	0.09		0.07	0.02	1.11	0.47
<u>H. dissimilis</u>	0.16	0.83	0.69	0.03	0.35	0.30	1.19	1.37
<u>H. insignis*</u>	2.75	1.05	0.19	0.01		0.54	0.67	0.39
<u>Notropis ariomus</u>	0.29	0.05	0.01		0.00			0.03
<u>N. cornutus</u>	0.03	0.07	0.14	0.01	0.07	0.11	0.26	0.08
<u>N. galacturus</u>	0.34	0.07	0.01		0.20	0.43	0.41	0.15
<u>N. photogenis</u>	0.00	0.00	0.01		0.03		0.09	0.06
<u>N. rubellus</u>	0.24	0.05	0.01		0.43	0.45	0.17	3.30
<u>N. sp. cf. N. spectrunculus</u>	1.19	2.93	0.07		0.00	0.02		0.07
<u>N. spilopterus</u>	0.67	0.05		0.00	0.07	0.04	0.00	0.09
<u>N. telescopus</u>	2.03	0.97	1.39	0.02	0.07	0.46	0.70	0.07
<u>Phenacobius uranops</u>	0.01	0.05	0.07	0.33	0.30	0.75	0.33	1.39
<u>Pimephales notatus</u>		0.00	0.00	0.00	0.00	0.00	0.07	0.01
<u>Hypentelium nigricans</u>	0.10	0.17	0.06	0.27	0.35	0.75	0.56	0.23
<u>Moxostoma duquesnei</u>	0.00	0.02	0.09	0.01	0.01	0.02	0.24	0.01
<u>M. erythrurum</u>	0.00	0.01	0.03		0.00	0.02	0.11	0.00
<u>Ictalurus punctatus**</u>	0.07	0.09	0.00		0.00	0.02	0.02	0.00
<u>Noturus eleutherus</u>	0.91	2.77			0.59	0.26	0.13	0.09
<u>Ambloplites rupestris</u>	0.01	0.08	0.06		0.00	0.00	0.04	0.00
<u>Lepomis megalotis</u>	0.07	0.10	0.27	0.00	0.00	0.02	0.00	0.01
<u>Micropterus dolomieu</u>	0.06	0.05	0.02		0.01	0.04	0.00	0.00
<u>M. punctulatus</u>	0.02	0.11	0.05		0.01	0.00		0.01
<u>Etheostoma blennioides</u>	0.41	0.61	0.14	0.10	0.58	4.75	0.70	0.50
<u>E. camurum</u>	0.21	0.36	0.00		0.37	0.00		0.11
<u>E. rufilineatum</u>	2.60	2.25	0.21	0.01	1.30	12.33	3.70	12.04

Table 8. (Continued)

Species	Duck RM 159.4	Duck RM 179.2	Duck RM 202.2	Duck RM 243.1	Clinch RM 189.5	Clinch RM 227.4	Copper Cr. RM 1.9	Powell RM 99.2
<u>E. zonale</u>	6.69	2.17	0.38		0.17	1.02	0.13	0.26
<u>E. stigmaeum</u> or <u>jessiae</u> ***	0.01	0.45	0.06		0.00	0.00	1.11	0.02
<u>E. maculatum</u> or <u>aquali</u> ***	0.65	0.52	0.07		0.01	0.00	0.06	0.01
<u>Percina caprodes</u>	0.20	0.24	0.03	0.11	0.05	0.00	0.02	0.10
<u>P. sciera</u>	0.01	0.08	0.01		0.00	0.00	0.00	0.01
<u>Cottus carolinae</u>	1.03	0.17	0.21	2.69	0.00	0.05		0.30
Total Number Species	42	43	39	22	42	41	34	39

*Overlap species for Q. intermedia only.

**Overlap species for C. caelata only.

***Similarities in systematics and preferred habitat merit considering the two species as a species group.

Table 8. (Continued)

	Powell RM 117.4	NF Holston RM 6.2	NF Holston RM 85.2	Nolichucky RM 27.8	Paint Rock RM 60.0	Elk RM 91.4	Buffalo RM 79.9
<u>Lepisosteus osseus</u>	0.00			0.00	0.00		
<u>Dorosoma cepedianum</u>	0.00				0.01		0.02
<u>Campostoma anomalum</u>	0.22	0.26	0.85	0.87	0.15	0.50	1.24
<u>Hybopsis amblops</u>	1.08	0.01		0.00	0.33	0.11	1.73
<u>H. dissimilis</u>	0.57	0.39	0.15		0.82	1.28	0.36
<u>H. insignis</u>	1.09			4.48	0.07		0.22
<u>Notropis ariommus</u>	0.00	0.00				0.02	0.07
<u>N. cornutus</u>	0.07	0.00	0.26	0.44	0.16	0.28	0.10
<u>N. galacturus</u>	0.05	0.46	0.09		0.60	0.13	0.59
<u>N. photogenis</u>	0.19	0.10	0.07	0.00		0.13	0.30
<u>N. rubellus</u>	5.92	1.46	0.50	3.96		0.48	0.02
<u>N. sp. cf. N. spectrunculus</u>	0.00	1.33	0.02		1.24	0.33	
<u>N. spilopterus</u>	0.01	0.03	0.00	2.11	0.19	0.06	0.01
<u>N. telescopus</u>	0.03	0.77	2.80	0.02	1.05	0.19	0.24
<u>Phenacobius uranops</u>	2.39	0.13	0.02	1.04		1.51	0.14
<u>Pimephales notatus</u>	0.03	0.00			0.06	0.00	0.03
<u>Hypentelium nigricans</u>	0.54	0.17	0.39	0.94	0.10	1.13	0.19
<u>Moxostoma duquensnei</u>	0.00	0.00	0.02	0.02	0.03	0.00	0.07
<u>M. erythrurum</u> **	0.00	0.00	0.00	0.00	0.02	0.00	0.00
<u>Ictalurus punctatus</u>	0.01		0.04	0.00	0.02	0.01	
<u>Noturus eleutherus</u>	0.27	0.57					
<u>Ambloplites rupestris</u>	0.01	0.08	0.11		0.09	0.00	0.04
<u>Lepomis megalotis</u>	0.00	0.00	0.00		0.47	0.00	0.00
<u>Micropterus dolomieu</u>	0.00	0.01	0.26	0.00	0.04		0.00
<u>M. punctulatus</u>	0.00	0.00		0.00	0.01		0.00
<u>Etheostoma blennioides</u>	0.92	0.83	0.37	3.76	0.13	2.28	0.02
<u>E. camurum</u>	0.07	1.15	0.30	2.09			
<u>E. rufilineatum</u>	9.31	7.88	4.63	0.02	2.25	0.50	0.03
<u>E. zonale</u>	0.71	0.42	0.00	0.59	0.10	0.43	0.58
<u>E. stigmaeum</u> or <u>jessiae</u> ***	0.32			0.00	0.53	0.00	0.07
<u>E. maculatum</u> or <u>aquali</u> ***	0.00		0.19	0.07			0.48

Table 8. (Continued)

	Powell RM 117.4	NF Holston RM 6.2	NF Holston RM 85.2	Nolichucky RM 27.8	Paint Rock RM 60.0	Elk RM 91.4	Buffalo RM 79.9
<u>Percina caprodes</u>	0.16		0.07		0.15	0.48	0.04
<u>P. sciera</u>	0.00				0.00		0.01
<u>Cottus carolinae</u>	0.32	0.10	0.17	1.31	0.36	2.39	0.30
Total Number Species	38	30	26	30	35	32	42

Table 9. Abundance of overlap fish species for Conradilla caelata and Quadrula intermedia at the 15 standard sampling sites based on total numbers collected (quantitative and qualitative samples) during Activity 8. Categories: Rare (R) = 1-10, Uncommon (U) = 11-100, Common (C) = 101-400, Abundant (A) = 401-1,000, Super Abundant (SA) = over 1,000.

Species	Duck RM 159.4	Duck RM 179.2	Duck RM 202.2	Duck RM 243.1	Clinch RM 189.5	Clinch RM 227.4	Copper Cr. RM 1.9	Powell RM 99.2
<u>Lepisosteus osseus</u>	R	R	R		R	R	R	R
<u>Dorosoma cepedianum</u>	R	U	R		U	U	R	R
<u>Camptostoma anomalum</u>	U	C	U	SA	U	A	U	C
<u>Hybopsis amblops</u>	U	U	U		U	R	C	C
<u>H. dissimilis</u>	U	C	C	R	U	U	C	C
<u>H. insignis*</u>	C	C	U	R		U	U	U
<u>Notropis ariommus</u>	U	U	R		R			U
<u>N. cornutus</u>	U	U	U	U	C	C	C	U
<u>N. galacturus</u>	U	U	R		C	U	U	U
<u>N. photogenis</u>	R	R	R		U		U	U
<u>N. rubellus</u>	C	U	R		U	U	U	A
<u>N. sp. cf. N. spectrunculus</u>	C	A	U		U	R		U
<u>N. spilopterus</u>	C	U		R	C	U	R	U
<u>N. telescopus</u>	A	C	C	R	U	C	C	U
<u>Phenacobius uranops</u>	R	U	R	U	U	U	U	C
<u>Pimephales notatus</u>		U	R	R	U		R	U
<u>Hypentelium nigricans</u>	U	U	R	U	U	C	U	U
<u>Moxostoma duquesnei</u>	R	R	U	R	U	R	U	U
<u>M. erythrurum</u>	R	R	U		R	R	U	R
<u>Ictalurus punctatus**</u>	U	U	R		R			
<u>Noturus eleutherus</u>	C	A			U	U	R	U
<u>Ambloplites rupestris</u>	U	U	U		U	U	U	U
<u>Lepomis megalotis</u>	C	C	U	R	U	U	R	U
<u>Micropterus dolomieu</u>	U	U	R		U	U	R	R
<u>M. punctulatus</u>	U	U	U		U	R		U
<u>Etheostoma blennioides</u>	U	C	U	U	U	A	U	U
<u>E. camurum</u>	U	U	R		U	R		U
<u>E. rufileineatum</u>	C	C	U	R	C	SA	C	SA

Table 9. (Continued)

Species	Duck RM 159.4	Duck RM 179.2	Duck RM 202.2	Duck RM 243.1	Clinch RM 189.5	Clinch RM 227.4	Copper Cr. RM 1.9	Powell RM 99.2
<u>E. zonale</u>	A	C	U		U	C	U	U
<u>E. stigmaeum</u> or <u>E. jessiae</u> ***	R	U	U		R	R	U	U
<u>E. maculatum</u> or <u>E. aquali</u> ***	U	U	R		R	R	R	R
<u>Percina caprodes</u>	U	U	R	U	R	R	R	U
<u>P. sciera</u>	R	U	R		R	R	R	R
<u>Cottus carolinae</u>	C	U	U	A	R	R		U

*Overlap species for Q. intermedia only.

**Overlap species for C. caelata only.

***Similarities in systematics and preferred habitat merit considering the two species as a species group.

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Table 9. (Continued)

	Powell RM 117.4	NF Holston RM 6.2	NF Holston RM 85.2	Nolichucky RM 27.8	Paint Rock RM 60.0	Elk RM 91.4	Buffalo RM 79.9
<u>Lepisosteus osseus</u>	R			R	R		R
<u>Dorosoma cepedianum</u>	R				R		
<u>Camptostoma anomalum</u>	C	U	C	U	U	C	C
<u>Hybopsis amblops</u>	C	R		R	U	U	C
<u>H. dissimilis</u>	C	U	R		C	U	U
<u>H. insignis*</u>	C			C	R		U
<u>Notropis ariommus</u>	U	R				R	U
<u>N. cornutus</u>	U	C	U	C	U	A	C
<u>N. galacturus</u>	U	C	U		C	C	C
<u>N. photogenis</u>	U	U	U	R		C	C
<u>N. rubellus</u>	SA	C	U	A		C	R
<u>N. sp. cf. N. spectrunculus</u>	R	A	U		C	C	
<u>N. spilopterus</u>	U	R	R	A	U	U	U
<u>N. telescopus</u>	U	C	A	R	C	U	C
<u>Phenacobius uranops</u>	C	U	R	U		U	U
<u>Pimephales notatus</u>	U				R	R	U
<u>Hypentelium nigricans</u>	U	U	U	C	U	C	U
<u>Moxostoma duquesnei</u>	U	U	R	R	R	U	U
<u>M. erythrurum</u>	R	R	R	U	R	R	U
<u>Ictalurus punctatus**</u>		R		R	R	R	R
<u>Noturus eleutherus</u>	U	U					
<u>Ambloplites rupestris</u>	U	U	C		R	U	U
<u>Lepomis megalotis</u>	R	R	R		C	R	U
<u>Micropterus dolomieu</u>	R	U	U	U	U		R
<u>M. punctulatus</u>	R	R		R	R		R
<u>Etheostoma blennioides</u>	C	C	U	C	U	C	R
<u>E. camurum</u>	U	C	U	C			
<u>E. rufilineatum</u>	SA	SA	C	R	C	U	R
<u>E. zonale</u>	U	U	R	U	U	U	U
<u>E. stigmaeum</u> or <u>E. jessiae***</u>	U			R	U	U	U
<u>E. maculatum</u> or <u>E. aquali***</u>	R		U				U
<u>Percina caprodes</u>	U		R		U	U	R
<u>P. sciera</u>	R				R		R
<u>Cottus carolinae</u>	U	U	U	U	U	C	U

Table 10. Percent of overlap fish species (those collected from each site* containing Conradilla caelata populations) found at standard sampling sites without C. caelata populations.

Location	Percent
Duck River Mile 159.4	97
Powell River Mile 117.4	97
Clinch River Mile 227.4	94
Duck River Mile 202.2	94
Buffalo River Mile 79.9	91
Copper Creek Mile 1.9	85
Paint Rock River Mile 60.0	79
North Fork Holston River Mile 6.2	79
Elk River Mile 91.4	76
North Fork Holston River Mile 85.2	70
Nolichucky River Mile 27.8	67
Duck River Mile 243.1	42

*Sites with C. caelata include: Duck River Mile 179.2, Powell River Mile 99.2, and Clinch River Mile 189.5.

Table 11. Percent of overlap fish species (those collected from each site* containing naturally occurring Quadrula intermedia populations) found at standard sampling sites without Q. intermedia populations.

Location	Percent
Duck River Mile 159.4	97
Clinch River Mile 189.5	97
Clinch River Mile 227.4	94
Duck River Mile 202.2	94
Buffalo River Mile 79.9	91
Copper Creek Mile 1.9	85
Paint Rock River Mile 60.0	79
North Fork Holston River Mile 6.2	79
Elk River Mile 91.4	73
North Fork Holston River Mile 85.2	70
Nolichucky River Mile 27.8	67
Duck River Mile 243.1	46

*Sites with Q. intermedia include: Duck River Mile 179.1, Powell River Mile 99.2, and Powell River Mile 117.4.

Table 12. Rankings, weighted by number of samples and relative abundance of twentieth-five potential host fish species for Cumberlandian mollusks

Species		Overall Rank	Rank (Sites)	Rank (Sites)
Scientific Name	Common Name		With Mollusks	Without Mollusks
<u>Etheostoma rufilineatum</u>	Redline darter	1	1	5
<u>Campostom anomalum</u>	Central stoneroller	2	2	3
<u>Notropis galacturus</u>	Whitetail shiner	3	3	8.5
<u>N. cornutus</u>	Common shiner	4	6	1
<u>N. spilopterus</u>	Spotfin shiner	5	4	13
<u>N. rubellus</u>	Rosyface shiner	6	5	14
<u>N. telescopus</u>	Telescope shiner	7.5	12	2
<u>Hypentelium nigricans</u>	Northern hogsucker	7.5	8	7
<u>Cottus carolinae</u>	Banded sculpin	9	7	12
<u>Etheostoma blennioides</u>	Greenside darter	10	10	11
<u>E. zonale</u>	Banded darter	11	11	8.5
<u>Hybopsis amblops</u>	Bigeye chub	12	9	10
<u>H. dissimilis</u>	Streamline chub	14.5	18	18
<u>Lepomis megalotis</u>	Longear sunfish	14.5	15	24
<u>Notropis</u> (undescribed)	Sawfin shiner	16	14	26
<u>Hybopsis insignis</u>	Blotched chub	17	16	20
<u>Phenacobius uranops</u>	Stargazing minnow	18	20	22
<u>Etheostoma simoterum</u>	Tennessee snubnose darter	19	25	6

Table 12 (Continued)

Species		Overall Rank	Rank (Sites)	Rank (Sites)
Scientific Name	Common Name		With Mollusks	Without Mollusks
<u>Pimephales notatus</u>	Bluntnose minnow	20.5	19	39
<u>Noturus eleutherus</u>	Mountain madtom	20.5	17	43
<u>Percina caprodes</u>	Logperch	22	21	28
<u>Moxostoma duquesnei</u>	Black redbreast	23	27	16
<u>Micropterus dolomieu</u>	Smallmouth bass	24	28	19
<u>Etheostoma caeruleum</u>	Bluebreast darter	25	23	27

¹The mean number of species that comprised one percent or more of the total fish collected was 19 (S.D. = 3). The twenty-five species listed here include the 19 species plus two standard deviations ($2 \times \text{S.D.} = 6$) for a total of 25.

Table 13. A classification of 15 study reaches in descending order, that either have surviving populations of *Conradilla caelata* and *Quadrula intermedia* or could serve as relocation sites for these mussel species.

Site (River Mile)	Rank	<i>Conradilla caelata</i> Cumberlandian		Total Mussel Species (Cumberlandian)	Rank	<i>Quadrula intermedia</i> Cumberlandian	
		Species in Common	Percentage Overlap			Species in Common	Percentage Overlap
Kyles Ford (CRM 189.5)	1*	10	100	33(11)	1.5	9	98
Fletcher Ford (PRM 117.4)	2	10	97	25(10)	1.5*	9	100
Lillard's Mill (DRM 179.1)	4*	7	100	24(8)	6	5	100
Buchanan Ford (PRM 99.2)	4	7	100	22(9)	3*	8	100
Saltville (NFHRM 85.2)	4	7	70	10(8)	4.5	6	70
Copper Creek (CCRM 1.9)	6	6	85	10(8)	4.5	6	85
Paint Rock (PRM 60.0)	7	5	79	10(6)	7	4	79
Elk River (ERM 91.4)	8.5	4	76	10(4)	8.5	3	73
Click Island (NFHRM 6.2)	8.5	4	79	7(4)	8.5	3	79
Ft. Blackmore (CRM 227.4)	10	3	94	9(3)	10	2	94

Table 13 (Continued)

Site (River Mile)	<i>Conradilla caelata</i>			Total Mussel Species (Cumberlandian)	<i>Quadrula intermedia</i>		
	Rank	Cumberlandian Species in Common	Percentage Overlap		Rank	Cumberlandian Species in Common	Percentage Overlap
Sowell Ford (DRM 159.4)	11	2	97	5(2)	11	1	97
Hall Mill (DRM 202.2)	12.5	1	94	3(1)	13.5	0	94
Dement Bridge (DRM 243.1)	12.5	1	42	1(1)	13.5	0	46
Nolichucky (NRM 27.8)	14.5	0	67	8(0)	13.5	0	67
Buffalo (BFM 79.9)	14.5	0	91	1(0)	13.5	0	91

* Endangered species present.

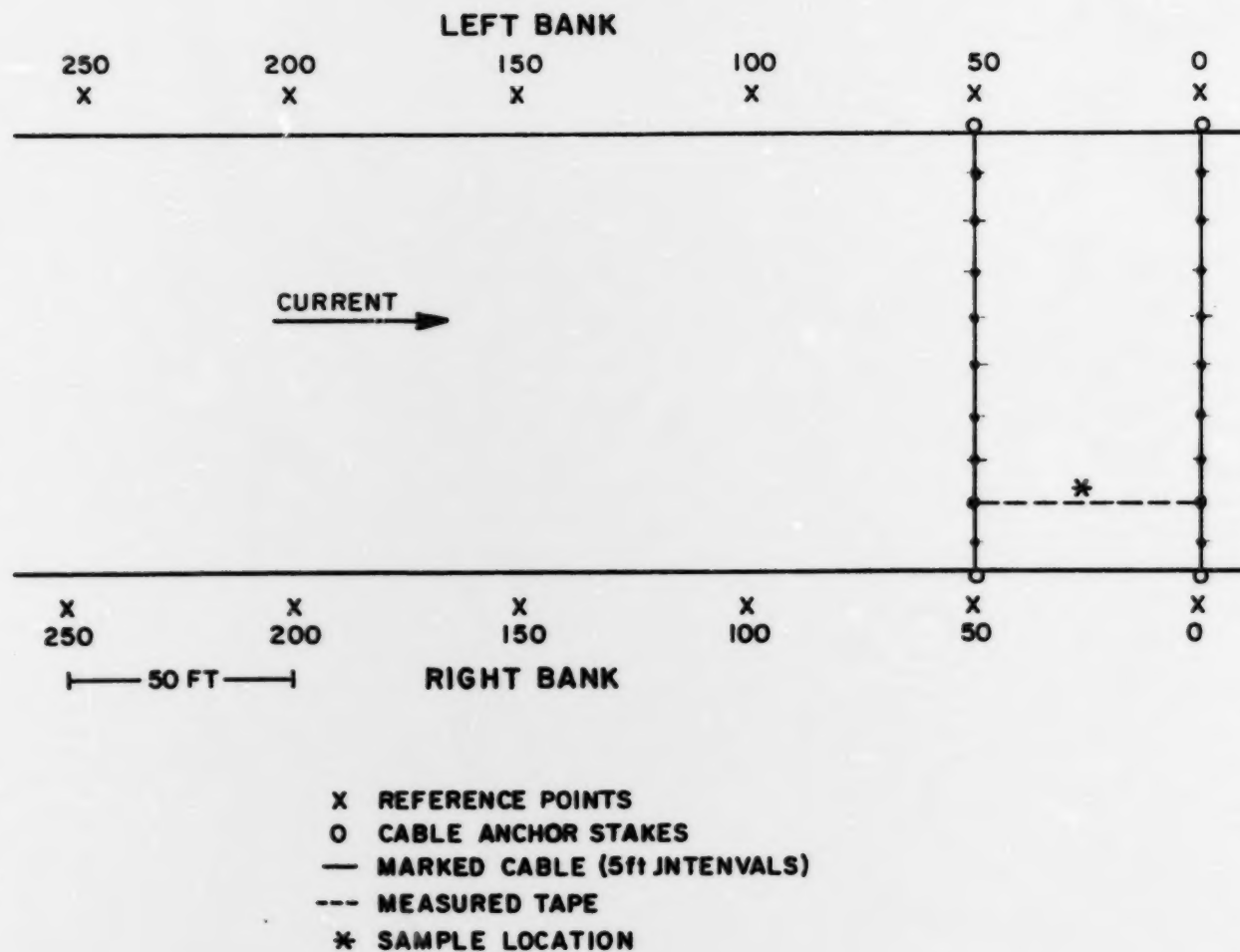


Figure 1: Illustration of Procedure used to Locate Sample Cell at the Fifteen Standard Sample Cites

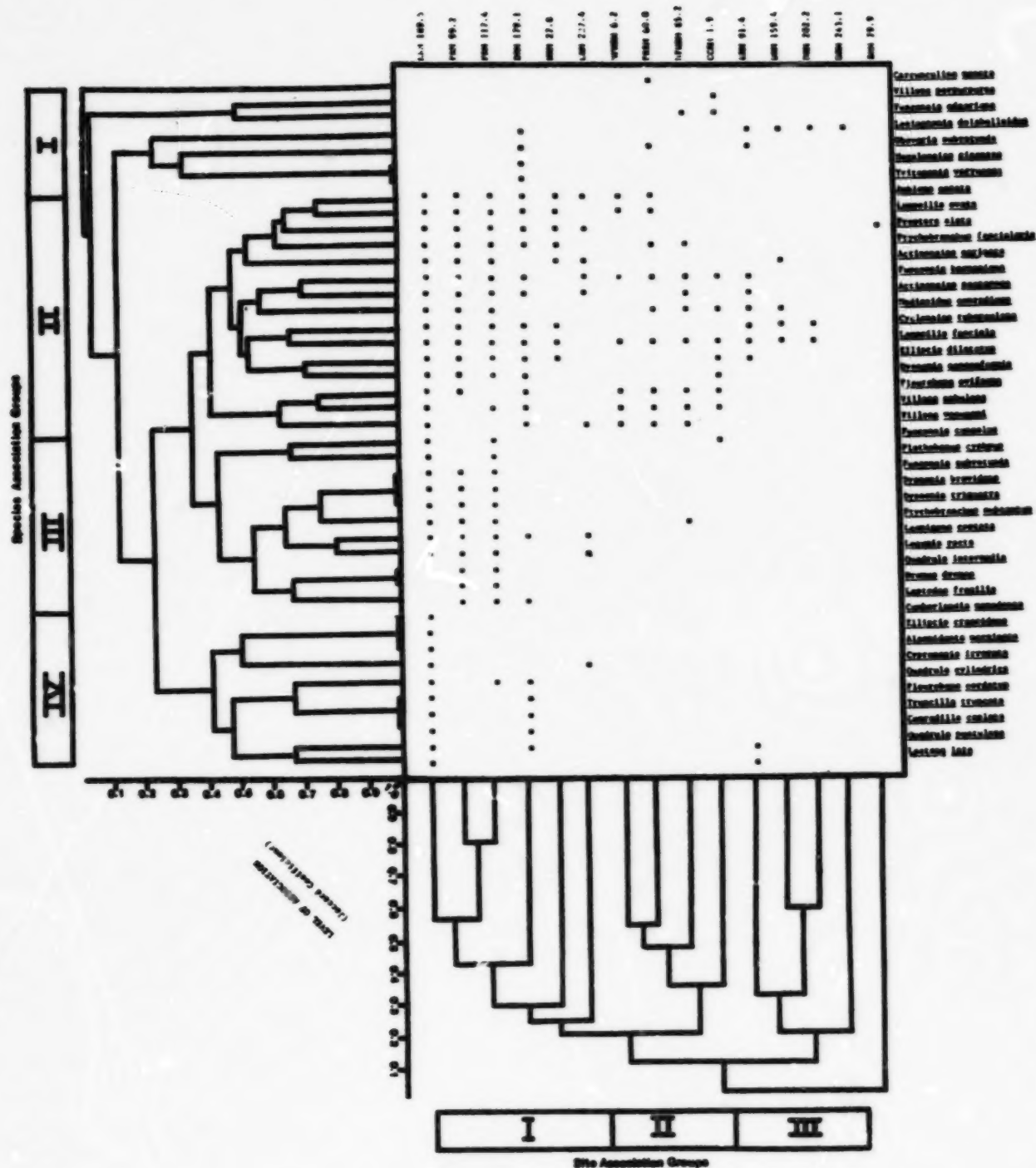


Figure 2. Two-way cluster analysis of the distribution of 43 species of freshwater mussels (vertical axis) in the 15 standard sampling sites (horizontal axis).

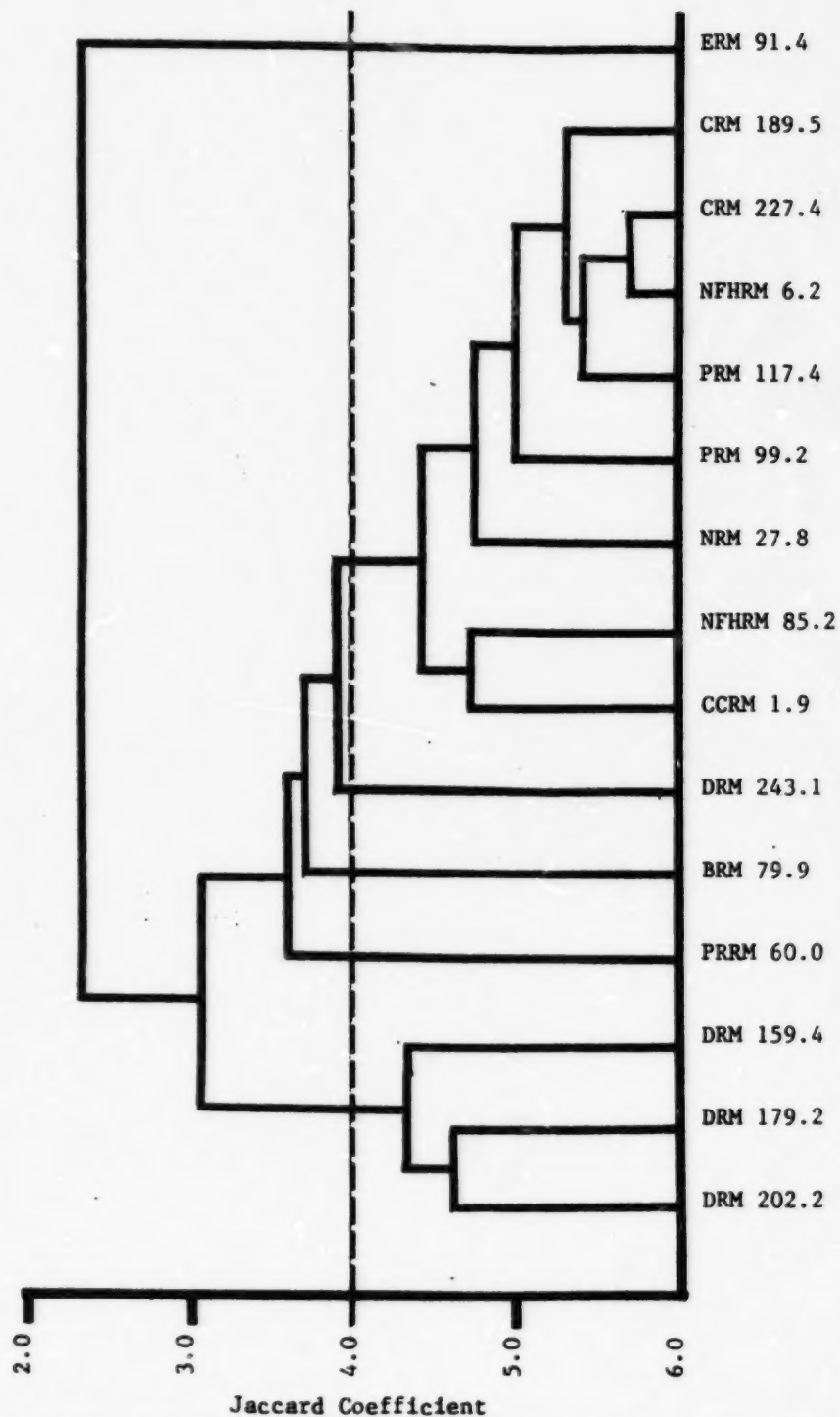


Figure 3. Cluster analysis of the distribution of 201 taxa of benthic macroinvertebrates in the 15 standard sampling sites.

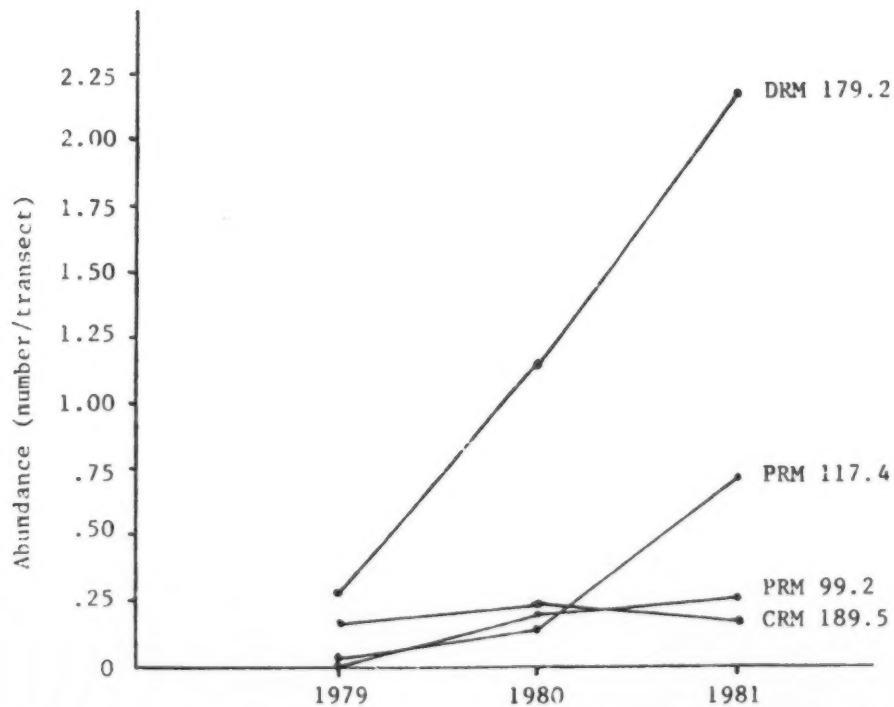


Figure 4. Relative abundance estimates for E. zonale at four study sites, 1979-81.

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APPENDIX

Table A-1

**POPULATION ESTIMATES, WITH 95 PERCENT
CONFIDENCE INTERVALS, OF MUSSEL SPECIES
OCCURRING AT EACH OF THE STANDARD
SAMPLING SITES**

Elk River

ERM 91.4

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
ACTINONAIAS PECTOROSA	1207.85	-1339.14	3754.84
CYCLONAIAS TUBERCULATA	1158.84	-1241.83	3559.51
FUSCINAIAS BARNESIANA	348.00	-1060.53	1756.53
QUADRULA PUSTULOSA	343.94	-1227.80	1915.68
LASTENA LATA	232.00	-1080.39	1544.39
LEPTINOTYPIA DOLABELLOIDES	228.23	-1063.01	1519.47
OPHOVATA SUBROTUNDA	116.00	-812.00	1044.00
NEOICHTHUS CONRADICUS	115.71	-809.97	1041.39
ELLIPTIO DILATATUS	112.52	-787.64	1012.68
LAEPHIS FASCIOLA	112.23	-785.61	1010.07

Clinch River

Kyles Ford - CRM 189.5

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
ACTINONAIAS CARINATA	47045.02	35116.72	58973.32
ACTINONAIAS PELTURIOSA	17876.00	10403.44	25348.55
PTYCHONAIAS SUPTENTUM	8716.65	2994.05	14439.24
MEDICINIOSUS CINNABICUS	7072.30	1943.34	12201.26
FUSCUNAIAS BUMPOTUNOA	3978.34	-75.21	8031.93
ELLIPTIUS DILATATUS	2480.19	-437.94	6598.36
CYCLONAIAS TUNEPULATA	2676.24	-942.23	6294.71
FUSCUNAIAS CUNEOLUS	2542.62	-942.17	6067.41
LAMBIA COSTATA	1813.39	-1325.33	4952.12
CAMBRIANAIAS MUNDONIA	1754.87	-1448.64	4956.58
LAMBIA FASCICULA	1517.73	-1271.00	4306.46
LAMBIA OVATA	1498.24	-1349.63	4306.30
PTYCHONAIAS FASCICULARIS	1219.02	-1344.25	3762.30
FUSCUNAIAS HANDESIANA	864.35	-1466.44	3195.15
QUADRILLA CYLINDRICA	790.75	-1475.74	3057.24
DYBONIA CAPSAEFURNIS	780.72	-1320.73	2882.17
VILLOSA NEBULOSA	771.26	-1543.61	3086.14
AMBIA COSTATA	680.91	-1384.06	2745.88
TRUNCILLA TRUNCATA	572.21	-1350.77	2595.19
LASTEA LATA	562.01	-1414.39	2538.41
CYPROGENIA INHUPATA	543.50	-1376.78	2463.79
ELLIPTIUS CHASSIDENS	337.48	-1208.47	1883.43
PLEURONEMA OVIFORME	336.98	-1221.13	1895.09
PLEURONEMUS LYPHYUS	223.71	-1005.48	1452.91
DYBONIA TRIGUETRA	222.29	-1016.28	1460.87
QUADRILLA PUSTULOSA	221.56	-1033.16	1476.28
LIGURIA RECTA	204.79	-919.34	1338.93
VILLOSA VANUAEMI	116.00	-812.00	1044.00
DYBONIA MNEVIDENS	113.10	-791.70	1017.90
PROPTERA ALATA	109.19	-736.62	955.01
ALABRIUM MARGINATA	105.48	-711.58	922.55
CINNAIDILLA CAELATA	102.39	-690.72	895.49
PLEURONEMA CURDATUM	102.39	-690.72	895.49

Clinch River

Fort Blackmore - CRM 227.4

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
ACTINONAIAS CAMINATA	550.33	-1172.32	2272.98
LASPHIGONA COSTATA	427.67	-1136.50	1991.84
ACTINONAIAS PECTOROSA	320.70	-956.07	1612.08
AMBLEMA COSTATA	107.08	-665.07	879.22
CYPROGENIA IRROGATA	105.88	-594.43	806.18
FUSCONATA HAMMESTANA	101.69	-602.86	806.25
LIGONIA RECTA	101.69	-602.86	806.25
PROPTENA ALATA	101.69	-602.86	806.25
VILLIUSA VANUZEMI	101.69	-602.86	806.25

BEST COPY AVAILABLE

Duck River

Sowell Ford - DRM 159.4

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
LAMPETIS FASCIOLA	566.39	-971.00	2103.78
ACTINACIAS CARINATA	116.00	-812.00	1044.00
CYCLONAS TUBERCULATA	116.00	-812.00	1044.00
LEXINGTONIA DOLABELLOIDES	116.00	-812.00	1044.00
PECIENICUS CONRADICUS	116.00	-812.00	1044.00

BEST COPY AVAILABLE

Duck River
Lillard Mill - DRM 179.1

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
CYCLONATAS TUREPULATA	22993.94	13726.75	32261.22
AMPHENA COSTATA	16586.04	7926.77	21233.31
DIADROMA PUSTULOSA	10108.94	4147.20	16070.67
CONOPIA CAELATA	8272.66	2395.55	14149.77
ELLIPTIO DILATATUS	3496.24	-235.46	7227.94
LEPTOGYNTA DILATELLUIDES	2665.40	-762.26	6133.06
LAMPYLIS FASCIOLA	1873.40	-1409.07	5155.87
TRITONIA VERRUCOSA	1513.10	-1373.92	4400.13
TRUNCILLA TRINEATA	1509.39	-1349.79	4368.57
MEGALONYX GIGANTEA	1394.55	-1642.54	4431.64
PROPTERA ALATA	1283.42	-1415.48	3982.52
LAMPYRONA COSTATA	1165.10	-1572.44	3902.66
LEPTONIA FRAGILIS	1050.26	-1417.91	3518.34
FIROCIATA HANNESIANA	1046.55	-1510.25	3603.36
QUADRULA CIVITRICA	591.14	-1169.89	2352.14
VILLIUS BANDEMI	466.55	-1384.47	2317.57
VILLIUS NERULOSA	235.71	-1076.17	1547.60
PLEUROMENA CURVATUM	232.00	-1080.39	1544.39
PLEUROMENA OVIFORME	229.68	-844.19	1303.55
DYSCHYIA CAPSAEFORMIS	154.67	-916.90	1226.23
PTYCHOMERUS FASCIOLARIS	119.71	-807.57	1047.00
ACTINONYX PECTOROSA	114.00	-812.00	1044.00
LAMPYLIS OVATA	116.00	-812.00	1044.00
IRIDIARIA SHROTHIANDA	114.84	-803.88	1033.56

Duck River
Hall Mill - DRM 202.2

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
LEXINGTONIA DOLABELLUIDES	232.00	-852.71	1310.71
CYLLONAIAS TUBERCULATA	110.00	-812.00	1040.00
LAMPYRIS FASCIOLA	110.00	-812.00	1040.00

BEST COPY AVAILABLE

Duck River

Dement Bridge - DRM 243.1

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
LEWISTONIA POLARIFLOIDES	116.00	-812.00	1044.00

Buffalo River

SPECTR	BRM 79.9	95 PCI CONFIDENCE LIMITS	
	ESTIMATED NUMBER	LOWER	UPPER
PRNDIFNA ALATA	232.00	-1000.30	1544.30

Powell River
Buchanan Ford - PRM 99.9

SPECIES	ESTIMATED NUMBER	95 PCI CONFIDENCE LIMITS LOWER	UPPER
ACTINOMIAIA PECTOROSA	22348.60	15453.71	29263.49
ACTINOMIAIA CARTATA	11367.12	6272.25	16461.99
MEGALOMIAIA CUMMINGSII	9553.16	4160.16	14946.02
ELLIPSYIA PLEURALIS	2472.48	-710.10	5655.07
MEGALOMIAIA RUPICOLA	1461.89	-1121.05	4444.84
AMPHIOMA COSTATA	1105.08	-1390.31	3600.47
DYSCHOMIA CAPSAICIFORMIS	898.59	-1388.05	3145.62
PSYCHOMIAIA FASCICULATA	893.97	-1285.86	3073.81
AMPHIOMA COSTATA	889.34	-1318.53	3097.21
DYSCHOMIA TETRACOMA	781.84	-1213.80	2777.88
PSYCHOMIAIA FASCICULATA	667.97	-1380.26	2716.20
CYCLOMIAIA TUBERCOLATA	338.89	-1009.67	1687.44
LEPTOMIAIA FRAGILIS	338.36	-995.72	1672.44
LIGOMIAIA MEXICA	230.84	-1074.99	1536.67
OROMIAIA MEXICA	229.97	-1070.95	1530.89
AMPHIOMA FASCICULATA	222.72	-1017.33	1462.77
AMPHIOMA COSTATA	222.72	-818.60	1264.04
PROPTOMA ALATA	115.42	-807.94	1030.78
DYSCHOMIA MEXICANA	114.55	-801.85	1030.95
DIADROMIA INTERMEDIA	114.55	-801.85	1030.95
PSYCHOMIAIA MEXICANA	107.30	-751.10	965.70
PLEUROMIAIA MEXICANA	107.30	-751.10	965.70

Powell River
Fletcher Fork - PRM 117.4

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
ACTINONAIAS PECTOROSA	10902.51	6674.36	14930.66
ACTINONAIAS CARINATA	6684.13	3258.28	10113.99
MEDIONAIAS CONRADICUS	3593.13	541.86	6604.40
ELLIPTIC OTHATATUS	2659.25	-95.00	5411.50
DYSNOPIA PREVIDENS	2218.52	-151.56	4588.60
FUSCONATA SUBROTONDA	2432.75	-342.66	4449.15
LASMOGONA COSTATA	1263.23	-707.62	3274.29
DYSNOPIA TRIUNETNA	841.07	-1147.17	2829.31
PROPTERA ALATA	743.57	-1049.30	2536.45
DYSNOPIA CAPRAEFORNIS	651.93	-972.39	2276.26
LEPTODEA FRAGILIS	604.39	-1073.50	2282.28
CYCLONATA TUBERCULATA	563.14	-873.82	2000.10
LAMPSTILIS OVATA	536.71	-956.03	2029.45
FUSCONAIA HANNESTANA	290.63	-769.54	1350.81
APHELA COSTATA	276.63	-920.46	1477.72
PTYCHORRANCHUS FASCIOLARIS	267.28	-872.51	1407.07
FUSCONAIA CUNEOLUS	107.34	-724.10	938.78
PLETHORASUS CYPHYUS	107.34	-724.10	938.78
VILLOSA NERULOSA	107.34	-724.10	938.78
ORONUS ORONUS	40.33	-609.33	789.98
QUADRILO INTERMEDIA	40.33	-609.33	789.98
LIGUMTA RECTA	83.91	-497.42	665.23
QUADRILO CYLINDRICA	83.91	-497.42	665.23
LAMPSTILIS FASCIOLA	81.83	-460.98	624.65
PTYCHORRANCHUS SURTENTUM	81.83	-460.98	624.65

North Fork Holston River

Click Island - NFHRM 6.2

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
LAMPYLIS FASCIOIA	4059.25	232.32	8686.18
LAMPYLIS OVATA	2317.84	-487.35	5523.02
VILLONA NEBULOSA	1143.00	-1101.15	3387.14
PLEUROCOMA OVIFRONS	114.00	-812.00	1044.00
VILLONA VANUXEMI	114.00	-812.00	1044.00
AMBLYNA CRISTATA	83.52	-588.64	751.68
RIBBONATA BARNESIANA	83.52	-588.64	751.68

North Fork Holston River

Saltville - NFHRM 85.2

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
METOPNIUS CIPRATICUS	14842.00	9742.61	19941.40
VILLORA AFALGSA	4178.46	979.81	7377.11
PUSCHIA EINGARIANA	1019.40	-988.31	3027.11
LAPPSTIS FASCIOLA	999.74	-1013.53	3013.01
PLEUROPHENA OVIFORME	961.66	-1200.70	3204.02
VILLISA VANUXEMT	624.69	-1197.60	2446.77
PTYCHORRANCHUS SUBTENTUM	573.83	-1098.70	2245.55
ACTINONATAS PECTOROSA	350.23	-908.90	1609.36
PTYCHIBRANCHUS FASCIOLARIS	283.26	-990.41	1556.93
PRINCIPATA RAMMESTANA	239.50	-1046.68	1525.67

Nolichucky River

NRM 27.8

SPECIES	ESTIMATED NUMBER	95 PCI CONFIDENCE LIMITS	
		LOWER	UPPER
LAMPISILIS FASCIOLA	300.39	-909.64	1510.41
CYCLONAIAS TUBERCULATA	285.90	-576.22	1150.02
ELLIPTIO DILATATUS	223.67	-707.87	1155.21
PHIPTENA ALATA	223.67	-707.87	1155.21
AMBLEMA COSTATA	190.60	-609.05	990.24
PTYCHURANCHUS FASCIULARIS	120.37	-500.52	757.27
LAMPISILIS OVATA	115.38	-778.36	1009.12
ACTINONAIAS CANINATA	95.30	-591.91	782.51

Paint Rock River

PRRM 60.0

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
VILLONA MERULOSA	1663.04	-465.59	3791.68
PUSCINATA HARNESIANA	804.04	-732.16	2340.23
HEPTOMERUS CONRADICUS	765.52	-911.93	2482.96
OROVARIA SUBROTUNDA	391.09	-432.34	1214.51
LAMPYLIA FASCICULA	302.53	-844.60	1453.65
VILLONIA VANUXEMI	287.48	-887.43	1462.39
PTYCHOPRAPHUS FASCICULARIS	232.00	-852.71	1316.71
PLETHORREMA OVIFERUM	144.22	-821.90	1210.33
LAMPYLIA OVATA	84.51	-547.93	716.96
CARPINOTINIA MOESTA	74.22	-335.67	492.10

Copper Creek

CCRM 1.9

SPECIES	ESTIMATED NUMBER	95 PCT CONFIDENCE LIMITS	
		LOWER	UPPER
VILLOSA PERPUNPUREA	1815.40	-824.56	4455.36
MEGIUNIDUS CONRADICUS	875.74	-1045.77	2847.26
VILLOSA NEBULOSA	804.75	-1188.45	2797.45
ELLIPTIO DILATATUS	649.48	-1014.21	2413.17
FUSCUNAIA BARNESIANA	508.08	-881.12	1897.28
FUSCUNAIA CUNEOLUS	338.66	-1097.02	1774.34
DYSNOPIA CARBAEFURNIS	318.42	-759.81	1376.65
LAMPSILIS FASCIOLA	317.55	-1151.18	1786.28
PLEUROMENA OVIFORNE	218.66	-1018.79	1456.11
FUSCUNAIA EDGARIANA	197.78	-728.44	1122.50

Table A-2

RELATIVE ABUNDANCE (NUMBER/m²)
OF MUSSEL SPECIES COLLECTED
AT THE FIFTEEN STANDARD
SAMPLING SITES, 1981

SPECIES	STATUS	ENN	CP	CU	U4	DR	DR	DR	DR	PR	PR	NFMR	NFMR	NH	PRH	CCW
		91.4	189.5	227.4	159.4	179.1	202.2	243.1	79.9	99.2	117.4	6.2	85.2	27.6	80.0	1.9
CUMBERLANDIA HUMIDATA		-	0.06	-	-	-	-	-	-	0.08	0.03	T	-	0.02	-	-
AMBLEMA COSTATA		-	0.02	0.01	-	0.06	-	-	-	0.01	0.03	T	0.02	-	0.14	0.08
FUSCONAIA BARNESIANA	C	0.02	0.03	T	-	0.05	-	-	-	-	-	-	-	-	-	0.05
FUSCONAIA CONEULUS	CF	-	0.09	-	-	-	-	-	-	0.12	0.21	-	-	-	-	-
FUSCONAIA SUBROTUNDA		-	0.14	-	-	-	-	-	-	-	-	-	0.10	-	-	0.03
FUSCONAIA EDGARIANA	CE	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-	-
QUADRULA CYLINDRICA		-	0.03	-	-	0.03	-	-	-	0.01	0.01	-	-	-	-	-
QUADRULA INTERMEDIA	CE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QUADRULA PUSTULOSA		0.02	0.01	-	-	0.46	-	-	-	-	-	-	-	-	-	-
TRITOGONIA VERRUCOSA		-	-	-	-	0.07	-	-	-	-	-	-	-	-	-	-
MEGALONAIAS GIGANTEA		-	-	-	-	0.06	-	-	-	-	-	-	-	-	-	-
CYCLONAIAS TUBERCULATA		0.07	0.09	-	0.01	1.04	0.01	-	-	0.02	0.06	-	-	0.02	-	-
ELLIPTIO CRASSIDENS		-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-
ELLIPTIO DILATATUS		0.01	0.10	-	-	0.16	-	-	-	0.18	0.27	-	-	0.02	-	0.11
LASTENA LATA		0.01	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-
LEXINGTONIA DOLABELLOIDES	C	0.01	-	-	0.01	0.12	0.02	0.01	-	-	-	-	-	-	-	-
PLEUROBASUS CYPHYUS		-	0.01	-	-	-	-	-	-	-	0.01	-	-	-	-	-
PLEUROBEMA CORDATUM		-	T	-	-	0.01	-	-	-	-	-	-	-	-	-	-
PLEUROBEMA OVIFORME	C	-	0.02	-	-	0.02	-	-	-	0.01	-	0.01	0.10	-	0.03	0.03
ALASHIDONTA MARGINATA		-	T	-	-	-	-	-	-	-	-	-	-	-	-	-
LASHIGONA COSTATA		-	0.06	0.02	-	0.05	-	-	-	0.02	0.13	-	-	-	-	-
ACTINONAIAS CARINATA		-	1.65	0.03	0.01	-	-	-	-	0.84	0.69	-	-	0.01	-	-
ACTINONAIAS PECTOROSA	C	0.07	0.63	0.02	-	0.01	-	-	-	1.65	1.12	-	0.04	-	-	-
CARUNCULINA MOESTA	C	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	-
DYSNOMIA BREVIDENS	C	-	0.01	-	-	-	-	-	-	0.01	0.23	-	-	-	-	-
DYSNOMIA CAPSAEFORMIS	C	-	0.03	-	-	0.01	-	-	-	0.07	0.07	-	-	-	-	0.05
DYSNOMIA TRIQUETRA		-	0.01	-	-	-	-	-	-	0.06	0.09	-	-	-	-	-
LAMPILIS FASCIOLA		0.01	0.05	-	0.04	0.08	0.01	-	-	0.02	0.01	0.20	0.10	0.03	0.05	0.05
LAMPILIS OVATA		-	0.05	-	-	0.01	-	-	-	0.07	0.06	0.10	-	0.01	0.01	-
LEPTODEA FRAGILIS		-	-	-	-	0.05	-	-	-	0.02	0.01	-	-	-	-	-
LIGUMIA NECTA		-	0.01	T	-	-	-	-	-	0.02	0.01	-	-	-	-	-
MEDIONIDUS CONRADICUS	C	0.01	0.25	-	0.01	-	-	-	-	0.70	0.37	-	1.51	-	0.13	0.14
OBOVARIA SUBROTUNDA		0.01	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-
PROPTERA ALATA		-	T	T	-	0.06	-	-	0.02	0.01	0.08	-	-	0.02	-	-
TRUNCILLA TRUNCATA		-	0.02	-	-	0.07	-	-	-	-	-	-	-	-	-	-
VILLOSA NEBULOSA	C	-	0.03	-	-	0.02	-	-	-	-	0.01	0.05	0.43	-	0.28	0.13
VILLOSA VANUXEMI	C	-	0.01	T	-	0.02	-	-	-	-	-	0.01	0.06	-	0.05	-
VILLOSA PERPUPUREA	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.28
CYPROGENIA IMPURATA		-	0.02	0.01	-	-	-	-	-	-	-	-	-	-	-	-
DROMUS DROMAS	CE	-	-	-	-	-	-	-	-	0.02	0.01	-	-	-	-	-
PTYCHOBANCHUS FASCIOLARIS		-	0.04	-	-	0.01	-	-	-	0.07	0.03	-	0.03	0.01	0.04	-
PTYCHOBANCHUS SURTENTUM	C	-	0.31	-	-	-	-	-	-	0.05	0.01	-	0.06	-	-	-
CONRADILLA CAELATA	CE	-	T	-	-	0.37	-	-	-	-	-	-	-	-	-	-

C = CUMBERLANDIAN SPECIES
 E = ENDANGERED SPECIES
 T = LESS THAN .005

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Table A-3

MEAN NUMBERS PER SQUARE-FOOT
OF BOTTOM FAUNA ORGANISMS COLLECTED
AT FIFTEEN STANDARD SAMPLING SITES.

SAMPLES WERE COLLECTED WITH AN
UNMODIFIED SURBER SQUARE-FOOT SAMPLER
ON A QUARTERLY BASIS JULY 1980
THROUGH 1981

SPECIES	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
	91.4	149.5	227.4	159.4	179.1	202.2	243.1	79.4	99.2	117.4	6.2	85.2	27.8	60.0	1.4		
NEMATODA	-	0.13	0.31	0.17	-	-	0.06	-	0.13	-	-	-	0.13	0.08	-		
TURBELLARIA																	
TRICLADIDA																	
PLANARIIDAE	-	-	1.56	-	0.68	-	-	0.08	-	-	-	-	-	-	-	0.08	
DUGESIA TIGRINA	-	0.25	0.38	-	-	-	0.17	-	-	-	0.25	-	0.63	-	-	-	
OLIGCHAETA																	
PLESIOPORA	1.38	3.94	0.39	1.82	1.31	0.63	0.50	-	0.94	0.19	0.75	0.63	0.44	1.58	0.33		
TURIFICIDAE	-	0.13	-	0.58	-	0.06	-	-	0.19	-	-	-	-	-	-	-	
BRANCHIURA SCHERBYI	-	-	-	-	-	-	-	0.17	-	-	-	-	-	-	-	-	
NAIDIDAE																	
PROBOPORA																	
BRANCHIODELLIDAE	0.88	0.44	3.25	0.42	-	0.13	0.19	0.08	1.44	0.06	0.63	0.19	0.88	1.42	0.08		
LUMBRICULIDAE	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	-	-	
MIRUDINEA																	
RHYNCHODELLIDA	-	-	-	-	0.06	-	-	-	-	-	0.06	-	-	-	-	-	
GLOSSIPHONTIDAE																	
CLITELLATA	-	0.19	0.81	-	-	-	0.06	-	-	-	0.38	-	0.56	-	-	-	
MAPLOTAXIDA																	
CRUSTACEA																	
ISOPODA																	
LIRCEUS SP.	-	-	-	-	0.06	-	-	0.33	0.06	-	-	-	0.13	-	0.08	-	
AMPHIPODA																	
GAMMARUS SP.	-	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CRANGONYX SP.	0.13	-	-	-	0.06	0.06	0.06	-	-	-	-	-	-	-	-	-	
DECAPODA																	
CAMBARUS SP.	-	-	0.06	-	-	-	0.06	-	-	-	-	0.06	-	-	-	0.25	
ORCONECTES SP.	-	0.13	0.13	-	-	0.31	0.13	-	-	0.13	0.25	0.06	-	0.17	0.08	-	
INSECTA																	
PLECOPTERA																	
PTERONARCYX SP.	-	-	0.06	-	-	-	-	0.08	-	-	-	-	-	-	-	-	
TAENIOPTERYX SP.	-	0.06	12.63	-	-	-	-	0.75	3.00	0.63	10.75	2.00	28.19	3.25	2.58	-	
BRACHYPTERA SP.	-	9.00	8.81	-	-	-	0.19	-	4.94	2.38	2.19	1.88	13.13	0.50	0.33	-	
NEMURA SP.	-	-	2.19	-	-	-	-	0.08	-	-	0.56	-	-	0.83	-	-	
CAPNIIDAE	0.13	-	-	0.17	0.06	0.31	-	-	-	-	0.31	-	-	-	-	-	
ALLOCAPNIA SP.	-	-	-	-	-	-	-	0.42	-	-	0.06	-	-	-	-	-	
PERLIDAE	-	0.44	-	1.08	0.25	0.31	-	-	0.13	-	-	-	-	-	-	-	
ACRONEURIA SP.	-	0.75	0.56	-	-	0.06	-	-	2.00	-	1.00	0.31	-	-	-	0.42	
NEOPERLA SP.	-	0.13	-	0.42	1.50	1.13	0.50	1.33	-	-	1.00	3.19	-	-	-	0.25	
PHASGANOPHORA SP.	-	0.50	2.00	0.63	1.75	0.13	-	0.25	1.25	0.44	1.19	-	-	-	-	0.25	
PHASGANOPHORA CAPITATA	-	-	0.88	-	-	0.31	-	-	-	0.06	1.25	-	-	-	-	-	
PERLETA SP.	-	-	-	0.67	0.13	0.50	-	-	-	-	-	-	-	-	-	-	
PERLETA PLACIDA	-	0.25	9.88	-	0.38	1.69	-	0.08	0.31	0.63	2.75	-	0.19	0.25	0.83	-	
ISOGENUS SP.	-	-	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	
ISOGENUS BILOBATUS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08	
ISOPERLA SP.	-	-	0.06	-	-	-	-	-	0.06	0.13	0.06	-	-	-	-	0.17	
CHLOROPERLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08	
ODONATA																	
GOMPHIDAE	-	-	-	-	0.13	-	-	-	-	0.25	-	-	-	-	-	-	
DRYMOGOMPHUS SP.	-	0.06	-	-	-	-	-	-	0.06	0.06	-	-	-	-	0.08	-	
GOMPHUS SP.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08	-	
MAGENIUS PREVISTIVUS	-	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LANTHUS PARVULUS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

BEST COPY AVAILABLE

SPECIES	EDM	CP	CC	DE	ER	DK	DF	HH	PH	PR	NFHR	NFHR	NF	PRH	CCR
	91.4	149.5	227.4	154.4	179.1	202.2	243.1	79.9	99.2	117.4	6.2	85.2	27.8	40.0	1.9
HELIOPSYPHE BOREALIS	-	-	-	-	-	-	-	-	-	-	0.06	-	-	-	-
MEGALOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIALIS SP.	-	0.19	-	0.08	0.06	-	0.06	0.08	-	0.06	0.13	-	-	-	0.08
CORYDALUS CORNUTUS	-	3.84	3.19	-	-	-	-	0.33	3.69	0.75	1.88	1.00	5.00	-	0.50
NIGRONIA SP.	-	0.06	-	0.08	-	-	0.06	-	0.25	0.06	0.06	0.06	0.06	-	0.08
LEPIDOPTERA	-	-	0.13	0.08	0.44	-	-	0.17	0.06	-	0.75	-	-	-	-
DIPTERA	-	0.13	-	-	-	-	-	-	0.06	-	-	-	-	0.08	-
SIMULIIDAE	-	-	-	0.08	-	-	0.25	-	-	-	-	-	-	-	-
SIMULIUM SP.	-	-	3.75	0.08	-	-	1.25	-	3.69	0.94	113.56	0.44	1.81	3.50	0.08
OLEPHARICERIDAE	-	0.06	-	-	-	-	-	-	-	-	-	3.19	0.13	-	0.08
TIPULIDAE	-	0.19	0.06	-	-	0.69	-	0.08	0.06	0.06	0.13	0.19	-	0.08	0.08
ERICERA SP.	-	-	-	-	0.13	-	-	-	-	-	-	-	-	-	-
TIPULA SP.	-	-	0.75	-	-	-	-	-	-	-	0.13	0.06	0.08	2.33	0.42
TIPULA ABDOMINALIS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
ANTICHA SP.	-	0.06	0.06	-	-	-	0.19	2.42	0.06	0.25	-	0.13	0.06	-	-
PROTOPLASA SP.	-	-	0.06	-	-	-	-	-	-	-	-	-	-	-	-
CERATOPOGONIDAE	-	-	-	-	-	0.06	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE	0.75	10.19	65.94	0.17	5.06	0.88	7.13	14.25	31.88	65.19	19.69	7.19	66.31	11.33	0.88
ABLAGESMYIA SP.	-	-	-	-	0.31	-	-	-	-	-	-	-	-	-	-
CHIRONOMUS SP.	-	-	-	-	0.13	-	-	-	-	-	-	-	-	-	-
CLINOTANYPUS SP.	-	-	-	-	0.25	-	-	-	-	-	-	-	-	-	-
COELOTANYPUS SP.	-	-	-	-	0.06	-	-	-	-	-	-	-	-	-	-
CONCHAELOPIS SP.	-	-	-	0.17	-	-	-	-	-	-	-	-	-	-	-
ERICOTOPUS SP.	-	-	-	-	0.06	-	-	-	-	-	-	-	-	-	-
CRYPTOCHIRONOMUS SP.	-	-	-	0.25	-	0.06	-	-	-	-	-	-	-	-	-
DICROTENDIPES SP.	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-
ENDOCHIRONOMUS SP.	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-
MICROTENDIPES SP.	-	-	-	-	-	0.06	-	0.17	0.06	-	0.44	0.13	0.06	-	-
POLYPEDILUM SP.	-	-	-	1.00	0.25	-	0.13	-	0.06	0.06	0.50	0.06	0.06	0.08	-
STRATIOMYIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	0.75	-
ATHERIX SP.	-	-	-	-	-	-	-	-	0.31	-	-	-	-	-	0.08
ATHERIX VARIEGATA	-	0.38	0.44	-	-	-	0.25	-	0.88	0.69	1.00	2.19	0.06	-	0.17
EMPIDIDAE	-	0.06	0.69	-	-	-	-	0.17	0.19	0.25	-	-	-	-	0.08
HEMERODROMIA SP.	-	-	-	-	-	-	-	-	-	0.06	0.06	-	-	-	-
COLEOPTERA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DERGUS SP.	-	-	0.06	-	-	-	-	-	-	-	0.06	-	-	0.33	-
MELICHUS SP.	-	-	0.25	-	-	-	-	-	-	-	0.06	-	0.06	0.92	-
ELMIDAE	-	0.31	-	-	-	-	0.44	-	-	-	0.06	0.06	-	0.33	-
ANCYRONYX VARIEGATUS	-	2.06	-	-	-	-	-	-	-	-	-	-	-	-	-
GUBIRAPHIA SP.	-	0.13	0.19	-	-	-	-	-	0.13	-	0.69	-	-	0.83	-
MACRONYCHUS SP.	-	-	0.25	-	-	-	-	0.08	0.38	0.25	0.13	0.13	0.13	0.17	-
MACRONYCHUS GLABRATUS	-	0.06	-	-	-	-	-	-	-	0.06	-	-	-	-	-
MICROCYLLOEPUS SP.	-	0.06	-	-	-	-	-	-	-	0.06	-	-	-	0.33	-
MICROCYLLOEPUS PUBILLUS	-	-	0.38	0.08	-	-	-	-	-	-	-	-	-	1.08	-
OPTIOBERVUS SP.	2.25	-	0.25	-	-	-	-	1.08	0.88	0.81	0.63	0.81	-	0.33	4.17
OPTIOBERVUS TRIVITTATUS	-	0.06	-	-	-	-	-	-	-	-	1.81	0.81	-	-	-
PRONTORESIA SP.	0.13	-	0.06	-	-	-	-	1.33	-	-	-	-	-	-	-
STENELIS SP.	1.13	11.13	15.25	5.33	10.63	5.00	1.94	0.92	21.48	8.13	14.88	8.13	1.63	3.33	2.30
GULINUS SP.	-	-	0.08	-	0.06	-	0.06	1.00	0.50	1.31	0.81	3.31	0.58	-	4.92
ECTOPARIA SP.	-	-	-	-	-	0.06	-	0.08	0.06	-	-	-	-	0.75	-
PERPHENUS SP.	0.13	2.63	0.98	-	0.44	2.50	0.25	0.98	0.19	0.19	4.25	6.81	0.25	1.08	0.88

GASTROPODA

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SPECIES	EM	CM	CP	DM	PR	OD	DR	BR	PR	PR	NFMR	NFMR	NR	PRR	CCR
	91.4	189.5	227.4	159.4	174.1	202.2	243.1	70.0	49.2	117.8	4.2	85.2	27.0	60.0	1.9
MESOGASTROPODA															
AMICOLA SP.	-	-	-	0.08	0.13	-	-	-	-	-	1.31	-	-	31.17	-
SOBATOGYRUS SP.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.50	-
PLEUROCERA (SYN. OXYTHEMA)	-	-	-	-	0.03	0.13	-	-	-	-	-	-	-	-	-
PLEUROCERA CANALICULATUM	-	1.13	1.31	-	-	-	-	-	1.36	0.88	4.56	1.30	1.63	-	0.75
PLEUROCERA UNCIAL	-	-	-	-	0.13	1.44	0.19	-	-	0.06	-	-	-	1.75	-
GONIOBASIS SP.	0.25	-	-	-	0.19	0.25	-	-	-	-	-	-	-	-	-
GONIOBASIS LARUEATA	-	-	-	-	0.19	0.25	-	-	-	-	-	-	-	-	-
LITHASIA GENICULATA	-	-	-	0.50	0.44	2.94	0.13	0.17	-	-	-	-	-	-	-
LITHASIA VERRUCOSA	3.75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANCULOSA BUNGLOBOSA	-	5.00	14.63	-	-	-	-	-	18.88	10.25	13.63	20.19	-	-	19.00
ANCULOSA PRAEROSA	1.08	-	-	0.75	0.69	1.25	-	-	-	-	-	-	0.75	-	-
IC FLUVIALIS	-	-	-	-	-	-	-	-	0.13	0.06	-	-	-	-	-
BAZOPHATOPHORA															
LYNNAEA SP.	-	0.06	-	0.08	-	-	0.06	0.25	0.44	-	0.63	-	-	1.08	-
FERRISSIA SP.	-	0.06	0.25	0.08	-	-	0.06	0.25	-	0.13	1.19	0.31	0.06	0.90	0.50
GYRAULUS SP.	-	-	-	-	-	-	-	-	-	-	0.13	-	-	-	-
PHYSA SP.	-	-	0.19	-	-	-	-	-	0.25	0.06	1.50	-	0.50	-	-
BIVALVIA															
METERODONTIDA															
CORRICULA PANILENSIS	4.88	7.65	6.56	9.50	7.56	8.88	10.08	1.92	3.63	4.31	3.31	-	31.06	5.92	0.08
FUSCONAIA CUNEOLUS	-	0.06	-	-	0.06	-	-	-	-	-	-	-	-	-	-
CYCLONAIAS TUBERCULATA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ACTINONAIAS CARINATA	-	-	-	0.25	-	-	-	-	0.06	-	-	-	-	-	-
ACTINONAIAS PECTOROSA	-	-	-	-	-	-	-	-	0.06	-	-	-	-	-	-
OYSONOMIA TRIQUETRA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LAMPISILIS FASCIOLA	-	-	-	0.08	-	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE	-	-	-	-	-	0.06	-	-	-	-	-	-	-	-	-
SPHAERIUM SP.	-	0.13	-	-	-	-	-	-	1.19	0.06	-	0.25	0.13	0.90	-
PSOTIUM SP.	-	-	-	-	-	-	-	-	-	-	-	-	1.08	0.25	-

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Table A-4

**BENTHIC MACROINVERTEBRATE SPECIES OCCURRENCE
AT THE FIFTEEN STANDARD SAMPLING SITES.**

**DATA ARE BASED ON BOTH QUALITATIVE AND
QUANTITATIVE SAMPLES.**

SPECIES	EP	CR	CP	DR	DN	DP	DR	CP	DP	CP	DP	CP	DP	CP	DP	CP	DP
91.4 149.5 227.0 159.0 170.1 202.2 243.1 79.9 99.2 117.4 5.2 65.6 27.8 1.4																	
NEMATODA																	
TURBELLARIA																	
TRICLACIDA																	
PLANARIIDAE																	
DUBESIA TIGRINA																	
OLIGOCHAETA																	
PLESIOPORA																	
TUBIFICIDAE																	
BRANCHIURA SONERBYI																	
NAIDIDAE																	
PROSOPORA																	
BRANCHIODELLIDAE																	
LUMBRICULIDAE																	
HIRUDINEA																	
RHYNCHODELLIDA																	
GLASSIPHONIIDAE																	
PHARYNGODELLIDA																	
CLITELLATA																	
HAPLOTAXIOA																	
CRUSTACEA																	
ISOPODA																	
ADELLUS SP.																	
LINCEUS SP.																	
AMPHIPODA																	
HYALELLA AZTECA																	
SAMMARUS SP.																	
CRANGONYX SP.																	
DECAPODA																	
CAMBARUS SP.																	
ONCONNECTES SP.																	
INSECTA																	
PLECOPTERA																	
PTERONARCYS SP.																	
TAENIOPTERYX SP.																	
BRACHYPTERA SP.																	
NEHOURA SP.																	
CAPNIIDAE																	
ALLOCAPNIA SP.																	
PERLIDAE																	
ACRONEURIA SP.																	
NEOPERLA SP.																	
PHASGANOPHORA SP.																	
PHASGANOPHORA CAPITATA																	
PERLESTA SP.																	
PERLESTA PLACIOA																	
ISOGENUS SP.																	
ISOGENUS BILOBATUS																	
ISOPERLA SP.																	
CHLOROPERLIDAE																	
ODONATA																	
ZONPHIDAE																	
DROMOSONPHUS SP.																	

BEST COPY AVAILABLE

SPECIES	ENH	CH	CR	OP	OR	OP	OR	OP	OR	OP	OR	OP	OR	OP	OR	OP	OR
	91.4	159.5	227.4	159.4	179.1	202.2	243.1	79.9	99.2	117.4	6.2	45.2	27.0	86.1	1.4		
OPHIOGOMPHUS SPINOSUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GOMPHUS SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
HAGENIUS BREVISTYLUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LANTHUS PARVULUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
OPHIOGOMPHUS RUPINSULENSIS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PROGOMPHUS SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
STYLOGOMPHUS ALBISTYLUS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
BASIAESCHNA JANATA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
BOVETIA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
BOVETIA VINCEA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LADONA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MACRONIA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NEUROCORDULIA YAMAGUCHIENSIS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CALOPTERYX SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
METAFERINA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
COENAGRIONIDAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ARGIA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ENALLAGHA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ISCHNURA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MACRONIIDAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EPHEMEROPTERA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EPHEMERIDAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EPHEMERA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EPHODON SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
HEXAGENIA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
POTAMANTHUS SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CAENIS SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TRICORYTHODES SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EPHEMERELLA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EPHEMERELLA LATA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EPHEMERELLA SEPTENTRIONALIS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
BAETISCA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LEPTOPHLEBIIDAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MACROPHLEBIODES SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
LEPTOPHLEBIA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PARALEPTOPHLEBIA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
BAETIDAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
BAETIS SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
HETEROCLOEON SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PSEUDOCLOEON SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SIPHONURA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ISONYCHIA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
HEPTAGENIIDAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EPENUS SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
HEPTAGENIA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SMITHROGENA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
STENONEMA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
STENACRON SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CINYGULA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SIPHONURIDAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
HEMIPTERA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CORTIIDAE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

SPECIES	ED	LD	LDH	CD	LDH	LDH	LDH	LDH	LDH	LDH	LDH	LDH	LDH	LDH	LDH
	91.6	127.5	227.4	159.4	170.1	212.2	243.1	79.0	19.2	117.4	6.2	15.7	27.6	36.1	1.0
BELISTIMATIOAE															
BELOSTOMA SP.															
CHAGNELIA SP.															
TRICHOPTERA															
AGAPETUS SP.															
GLOSSOPHILA SP.															
HYVACOPHILA SP.															
CHIARRA SP.															
NEURECLIPSIS SP.															
POLYCENTRINUS SP.															
PSYCHOMYIA SP.															
HYDROPSYCHIDAE															
CHEUNATOPSYCHE SP.															
CHEUNATOPSYCHE HYDRA															
HYDROPSYCHE SP.															
MACRONEMA ZEBRATUM															
POTAMIA FLAVA															
HYDROPTILA SP.															
OENOTRICHIA SP.															
IRONOGUIA															
PSYCHOPSYCHE SP.															
LEPTOCERIDAE															
ATHEPSIDAE SP.															
OECETIS SP.															
TRIAENODES SP.															
LEPIDOSTOMA SP.															
BRACHYCENTRUS SP.															
BRACHYCENTRUS AMERICANUS															
BRACHYCENTRUS LATERALIS															
MACRONEMA SP.															
MELICOPSYCHE BOREALIS															
GOERA SP.															
MEGALOPTERA															
STALIS SP.															
CORYDALUS CORNUTUS															
NIGRONIA SP.															
LEPIDOPTERA															
DIPTERA															
SIMULIIDAE															
SIMULION SP.															
OLEPHARICERIDAE															
TIPULIDAE															
ERIOCERA SP.															
TIPULA SP.															
TIPULA ABDOMINALIS															
ANTICHA SP.															
PROTOPLABA SP.															
CENATOPHONIDAE															
CHIRONOMIDAE															
ABLABESHTIA SP.															
CHIRONOMUS SP.															
CLINOTANTHUS SP.															

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SPECIES	ERM	CH	CH	UP	LO	CH	OR	CO	PO	MA	SPH	CHH	ORH	MS	LS
	91.4	149.5	227.4	150.4	170.1	202.2	243.1	79.9	90.2	117.4	0.2	45.2	27.6	60.0	1.4
COELONTANYPUS SP.															
CONCHAELOPIS SP.															
CRICOTCPUS SP.															
CRYPTOCHIRONOMUS SP.															
DICROTENDIPES SP.															
ENDOCHIRONOMUS SP.															
MICROTENDIPES SP.															
POLYPEDILUM SP.															
PSEUDOCHEIRONOMUS															
TRIRELOS SP.															
STRATIOMYIIDAE															
ATHERIX SP.															
ATHERIX VARIEGATA															
TABANIDAE															
EMPHIDIDAE															
HEMERODROMIA SP.															
COLEOPTERA															
PELTODYTES SP.															
SYRINIDAE															
DINEUTUS SP.															
GRYRINUS SP.															
GEROSUS SP.															
TROPISTERMUS SP.															
HELICHUS SP.															
ELMIDAE															
ANCYRONYX VARIEGATUS															
DUBIRAPHIA SP.															
MACRONYCHUS SP.															
MACRONYCHUS GLABRATUS															
MICROCYLLOEPUS SP.															
MICROCYLLOEPUS PUBILLUS															
OPTIOSERVUS SP.															
OPTIOSERVUS TRIVITTATUS															
PROMOREZIA SP.															
STENELMIS SP.															
OULINNIUS SP.															
ECTOPARIA SP.															
PSEPHENUS SP.															
GASTROPODA															
MESOGASTROPODA															
CAMPOLONA SP.															
ANNICOLA SP.															
SOMATOSYRUS SP.															
PLEUROCERA (SYN. OXYTRENA) SP															
PLEUROCERA CANALICULATUM															
PLEUROCERA UNCIALE															
GONIORABIS SP.															
GONIORABIS EDGARIANA															
GONIORABIS LAQUEATA															
LITHASIA GENICULATA															
LITHASIA VERRUCOSA															
ANGULOSA SUBGLOBOSA															

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SPECIES	EP	CH	CR	DR	DE	DR	DP	BR	PL	PR	FR	GR	HR	IR	OR	CR
	41.4	149.5	227.4	159.4	179.1	202.2	243.1	79.9	99.2	117.4	6.2	85.2	27.8	60.6	1.4	
ANCULOSA PHAEROSA	.			.	.	.								.		
IO FLUVIALIS									.	.						
BASOMYATOPHORA																
LYNNAEA SP.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	.
FERRISSIA SP.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CYRAULUS SP.					.						.	.	.	.	.	.
PHYSA SP.			.		.				.	.	.	.	.	.	.	.
BIVALVIA																
HETERODONTIDA																
CORRICULA SP.									.							
CORRICULA MANILENSIS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PITCONATA CUNEOLOUS		.							.	.	.	.	.	.	.	.
CYCLONAIAS TUBERCULATA					.											
ACTINONAIAS CARINATA				.						.						
ACTINONAIAS PECTOROSA									.	.						
DYSNOIA TRIQUETRA									.	.						
LAMPISILIS FASCIOLA				.					.	.						
MEDIONIDUS CONRADICUS									.	.						
SPHAERIDAE						.	.		.	.		.	.	.	.	.
SPHAERIUM SP.		.					.		.	.		.	.	.	.	.
PSIDIUM SP.		.							.	.		.	.	.	.	.

Table A-5

RELATIVE ABUNDANCE OF ORDERS
OF BENTHIC MACROINVERTEBRATES
AT THE 15 STANDARD SAMPLING SITES

VALUES ARE THE PERCENTAGE
OF TOTAL NUMBER OF ORGANISMS COLLECTED
AT THAT SITE WHICH ARE REPRESENTED
BY A PARTICULAR ORDER

-78-

78

Table A-6

RELATIVE ABUNDANCE OF ORDERS
OF BENTHIC MACROINVERTEBRATES
AT THE 15 STANDARD SAMPLING SITES

VALUES ARE THE PERCENTAGE
OF TOTAL NUMBER OF ORGANISMS COLLECTED
AT THAT SITE WHICH ARE REPRESENTED
AT A PARTICULAR ORDER

FAMILY	EPH	CRH	CFH	DRH	DRN	DRM	JRH	QPH	PRH	PRM	NFHRN	NFHRN	NAP	PRPH	CCPH
	91.4	199.4	227.4	159.4	179.1	202.2	243.1	79.9	59.2	117.4	6.2	45.2	27.8	60.0	1.5
HEPATICA	-	0.10	0.11	0.35	-	-	0.15	-	0.07	-	-	-	0.04	0.08	-
PLANARIIDAE	-	-	0.53	-	1.62	-	-	0.13	-	-	-	-	-	-	0.05
OLIGONEURIDAE	-	0.20	0.13	-	-	-	-	0.25	-	-	0.10	-	0.22	-	-
TUBIFICIDAE	5.67	3.28	0.13	4.27	2.43	1.63	1.29	-	0.63	0.12	0.31	0.37	0.15	1.52	0.24
HAEMIDAE	-	-	-	-	-	-	-	0.25	-	-	-	-	-	-	-
BRANCHIOCELLIDAE	-	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-
LUMBRICULIDAE	3.61	0.35	1.09	0.99	-	0.30	0.45	0.13	0.81	0.04	0.26	0.11	0.30	1.36	0.06
HIRUDINAE	-	-	-	-	0.12	-	-	-	-	-	0.03	-	0.02	-	-
GLOSSIPHONIIDAE	-	-	-	-	-	-	-	-	-	-	0.16	-	-	-	-
HAPLOSTANIDAE	-	0.15	0.27	-	-	-	0.15	-	-	-	-	-	0.19	-	-
ASSELIDAE	-	-	-	-	0.12	-	-	0.51	0.04	-	-	-	0.04	-	0.06
GAMMARIDAE	0.52	0.05	-	-	0.12	0.15	0.15	-	-	-	-	-	-	-	-
DECAPODA	-	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-
ASTACIDAE	-	0.10	0.05	-	-	0.74	0.45	-	-	0.09	0.10	0.45	-	0.16	0.24
PTEROMARCIDAE	-	-	0.02	-	-	-	-	0.13	-	-	-	-	-	-	-
TAENIOPTERYGIDAE	-	10.55	5.87	-	-	-	0.45	1.15	4.45	1.94	5.35	2.30	14.23	3.60	2.13
NEPHROURIDAE	-	-	0.74	-	-	-	-	0.13	-	-	0.23	-	-	0.80	-
CAPNIDAE	0.52	-	-	0.36	0.12	0.74	-	0.64	-	-	0.16	-	-	-	-
PERLIDAE	-	1.67	3.13	6.41	7.42	9.81	1.20	2.54	2.07	0.73	2.97	2.08	0.06	0.24	1.28
PERLOIDAE	-	-	0.06	-	-	-	-	-	0.04	0.08	0.03	-	-	-	0.18
CHLOROPERLIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06
GORPHIDAE	-	0.10	-	-	0.23	0.15	-	-	0.04	0.20	-	-	-	0.16	-
AESCHNIDAE	-	-	-	-	-	-	-	-	-	-	0.03	-	-	0.08	-
CALOPTERYGIDAE	-	-	0.06	-	-	-	-	-	-	-	0.05	-	-	-	-
CENASERIDAE	-	0.66	0.11	0.36	0.12	0.15	-	0.51	-	0.04	0.28	0.15	0.11	0.32	0.06
EPHEMERIDAE	-	2.52	0.19	16.73	15.41	12.04	-	0.64	0.04	0.04	2.09	3.00	0.27	0.24	0.18
CAENIDAE	-	0.50	0.02	-	-	0.15	1.05	0.38	0.18	0.08	0.23	0.30	-	0.08	-
EPHEMERELLIDAE	3.09	1.31	6.92	4.98	2.55	4.75	0.75	16.92	2.91	3.80	0.85	0.37	10.12	12.88	2.73
BAETISIDAE	-	-	-	-	-	-	-	0.51	-	-	-	-	-	0.16	-
LEPTOPHEBIIDAE	-	0.05	-	-	-	-	-	-	-	-	2.00	-	-	0.16	-
BAETIDAE	0.52	19.23	10.96	2.31	0.12	1.63	3.61	9.25	21.78	14.08	1.32	14.87	11.20	1.52	11.78
HEPTAGENIIDAE	5.15	12.32	4.73	4.98	4.52	6.39	7.19	7.39	4.59	6.80	1.21	25.33	15.01	3.52	12.81
HYACOPHILIDAE	-	-	0.02	0.89	1.51	1.49	0.15	-	-	0.04	-	0.15	-	2.72	0.67
PHILOPOTANIDAE	-	-	-	-	-	-	-	-	-	-	0.34	3.82	-	-	10.26
PSYCHORYTHIDAE	0.52	0.05	0.02	0.18	0.12	0.30	-	1.91	0.07	-	0.05	-	-	-	0.12
HYDROPSYCHIDAE	1.03	11.66	25.21	6.58	11.94	1.79	25.96	6.49	13.05	10.40	5.71	7.23	9.28	0.72	23.19
HYDROPTILIDAE	0.52	0.15	1.22	1.96	-	-	-	20.26	0.42	-	0.03	-	-	0.72	0.12
LIMNETHIDAE	-	-	-	-	-	0.15	-	-	-	-	-	-	-	0.08	-
LEPTOCERIDAE	-	0.05	-	-	0.23	-	-	-	-	-	-	-	-	0.16	-
BRACHYCENTRIDAE	-	-	-	-	-	-	-	0.51	-	-	0.39	-	-	2.16	0.06
HELIOPSYCHIDAE	-	-	-	-	-	-	-	-	-	-	-	0.04	-	-	-
SIALIDAE	-	0.15	-	0.14	0.12	-	0.15	0.13	-	0.04	0.05	-	-	-	0.06
CORYDALIDAE	-	2.83	1.07	0.18	-	-	0.15	0.51	2.21	0.53	0.88	0.63	1.74	-	0.43
LEPIDOPTERA	-	-	0.04	0.18	0.41	-	-	0.25	0.04	-	0.31	-	-	-	-
DIPTERA	-	0.10	-	-	-	-	-	-	1.04	-	-	-	-	0.08	-
SIMULIIDAE	-	-	1.25	0.35	-	-	3.61	-	2.07	0.61	46.96	0.26	0.62	3.36	0.06
BLEPHARICERIDAE	-	0.15	-	-	-	-	-	-	-	-	-	1.89	0.04	-	0.05
TIPULIDAE	-	0.20	0.24	-	0.27	1.63	3.45	3.92	0.07	0.20	0.10	0.22	0.32	2.32	0.43
TANYDERIDAE	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	-
CERATOPOGONIDAE	-	-	-	-	-	0.15	-	-	-	-	-	-	-	-	-
CHIRONOMIDAE	19.59	8.23	22.20	12.28	11.36	2.38	17.47	22.01	17.96	42.25	8.53	4.38	22.89	10.96	6.52

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FAMILY	ERM	CRM	CPM	DRM	DDM	DDM	DDM	DDM	DDM	DDM	DDM	DDM	DDM	DDM	DDM	DDM
	91.4	149.7	227.4	159.4	179.1	202.2	241.1	79.9	99.2	117.4	6.2	85.2	27.8	50.0	1.7	
STRATIOPYIIDAE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.72	-
AMAGIONIDAE	-	0.10	0.15	-	-	-	3.60	-	0.67	0.45	0.41	1.30	0.02	-	-	3.18
EMPTIIDAE	-	0.05	0.23	-	-	-	-	0.25	0.11	0.20	0.03	-	-	-	-	0.56
HYDROPHILICAE	-	-	0.02	-	-	-	-	-	-	-	0.03	-	-	-	0.32	-
DRYOPIDAE	-	-	0.04	-	-	-	-	-	-	-	0.03	-	0.02	0.02	-	-
ELMIDAE	10.43	9.54	5.13	11.57	19.81	11.83	5.87	6.74	13.08	6.44	7.86	11.42	0.80	6.16	8.98	-
PSEPHENIDAE	0.52	2.12	0.17	-	0.81	6.09	3.50	1.02	3.14	3.12	1.76	4.04	0.09	1.76	5.83	-
BITHYNIDAE	-	-	-	0.14	0.23	-	-	-	-	-	0.54	-	-	-	29.92	-
PLEUROCEPIDAE	24.23	4.95	5.37	2.67	3.82	14.26	3.75	3.25	9.29	7.28	7.52	12.87	0.82	2.16	11.48	-
LYMNIDAE	-	0.05	-	-	-	-	-	-	0.25	-	0.26	-	-	-	1.04	-
ANCYLIDAE	-	0.05	0.08	0.14	-	-	0.15	0.39	-	0.08	0.49	0.19	0.02	0.48	0.36	-
PLANCIDAE	-	-	-	-	-	-	-	-	-	-	0.05	-	-	-	-	-
PHYSIDAE	-	-	0.06	-	-	-	-	-	0.14	0.04	0.62	-	0.17	-	-	-
CYRENIDAE	20.10	6.16	2.21	20.24	14.02	21.10	24.25	2.93	2.83	2.79	1.37	-	10.70	5.64	0.06	-
UNIONIDAE	-	0.05	-	0.71	0.12	-	-	-	0.07	-	-	-	-	-	-	-
SPHAERIIDAE	-	0.10	-	-	-	0.15	-	-	0.67	0.04	-	0.15	0.39	0.72	-	-

LEGEND:

— = AREAS DRY DURING SAMPLED LOW-FLOW CONDITIONS

a x b = LOCATION OF SAMPLE

x = LOCATION

a = NUMBER OF MUSSELS COLLECTED

b = SURFACE SUBSTRATE TYPE

SUBSTRATE TYPES

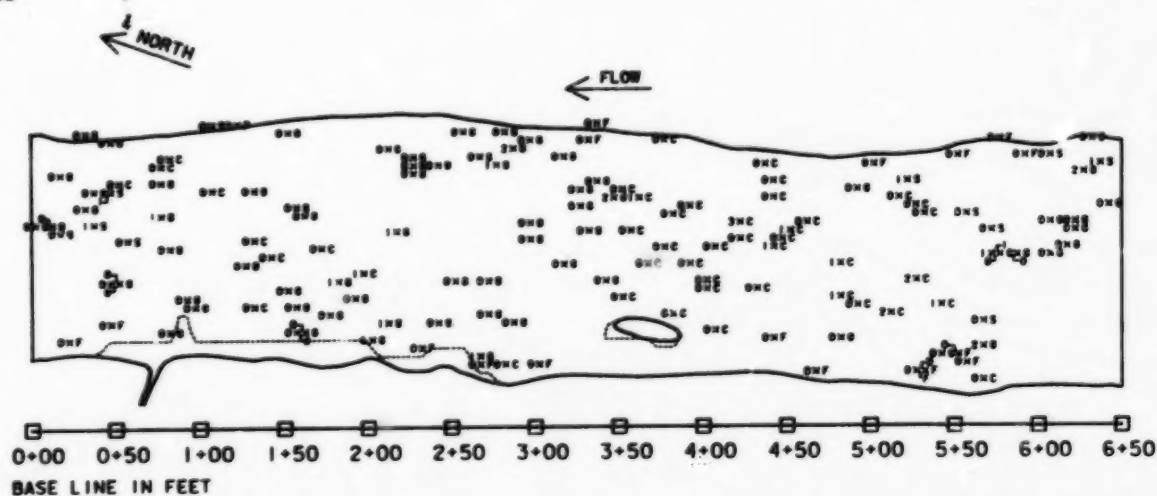
F = FINE PARTICLES (SILT AND CLAY)

S = SAND

G = GRAVEL

C = COBBLE

R = ROCK



CMCP - ELK RIVER, RM 91.4

Figure A-1. Total mussels collected and substrate type (surface) at each sample cell location for study reach ERM 91.4.

LEGEND:

----- = AREAS DRY DURING SAMPLED LOW-FLOW CONDITIONS

a x b = LOCATION OF SAMPLE

x = LOCATION

a = NUMBER OF MUSSELS COLLECTED

b = SURFACE SUBSTRATE TYPE

SUBSTRATE TYPES

F = FINE PARTICLES (SILT AND CLAY)

S = SAND

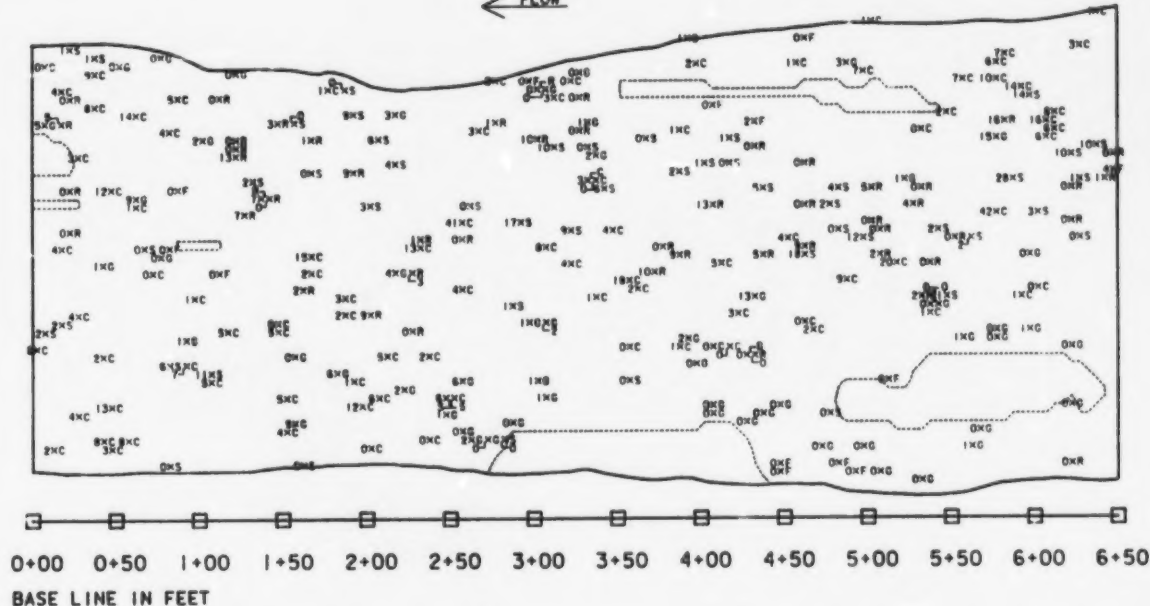
G = GRAVEL

C = COBBLE

R = ROCK

NORTH →

← FLOW



CMCP - CLINCE RIVER, RM 189.5, KYLES FORD

Figure A-2. Total mussels collected and substrate type (surface) at each sample cell location for study reach CRM 189.5.

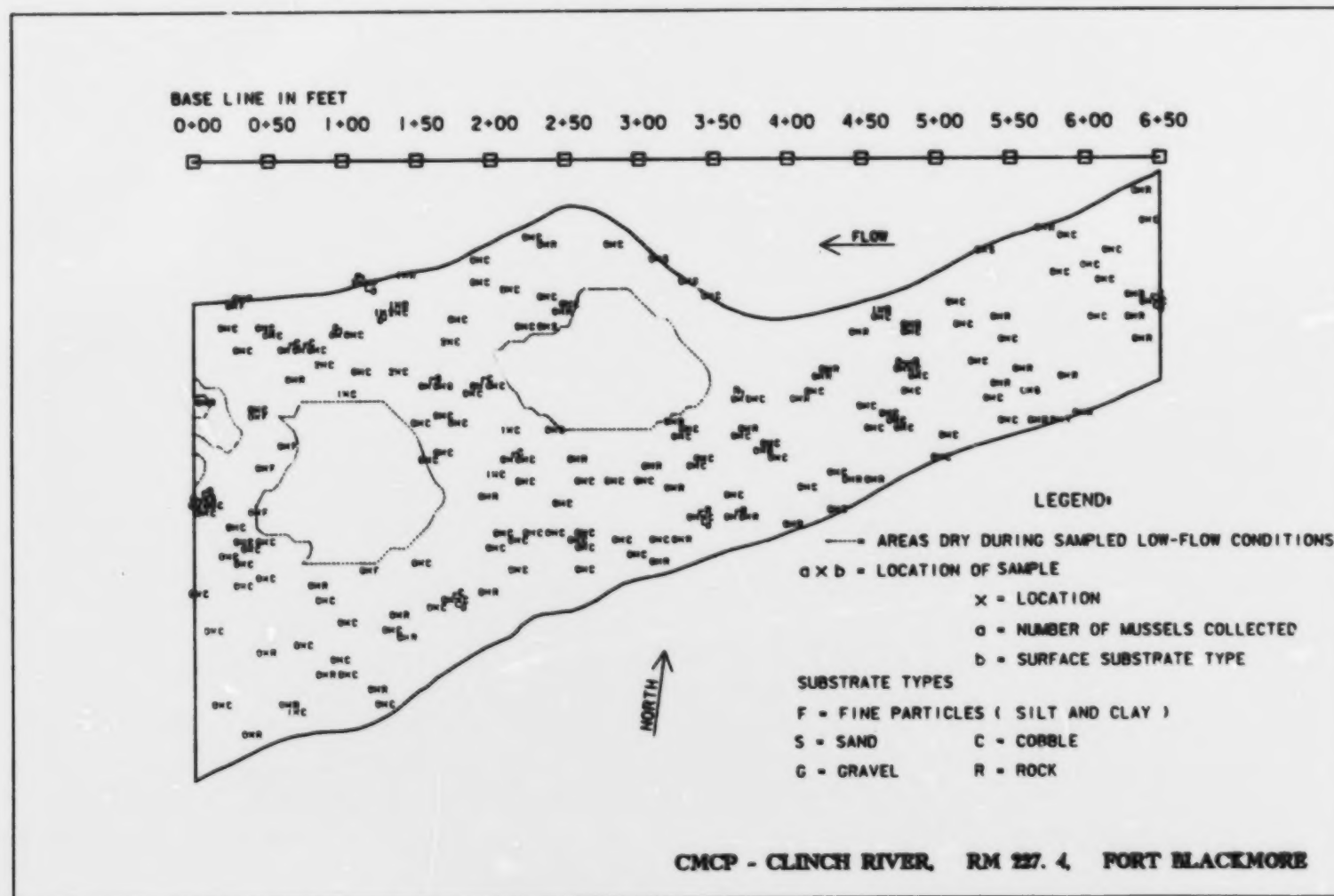


Figure A-3. Total mussels collected and substrate type (surface) at each sample cell location for study reach CRM 227.4.

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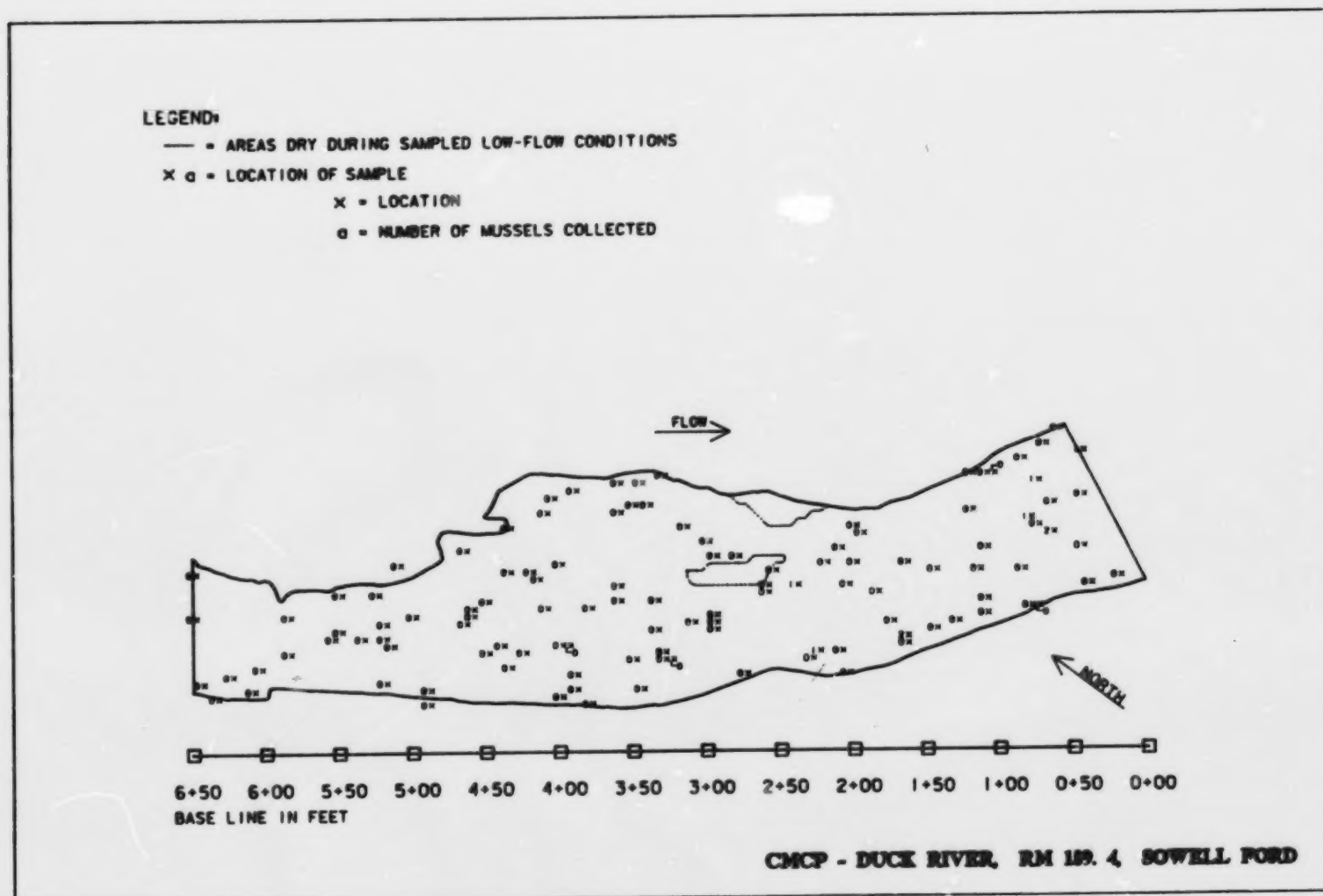


Figure A-4. Total mussels collected and substrate type (surface) at each sample cell location for study reach DRM 159.4.

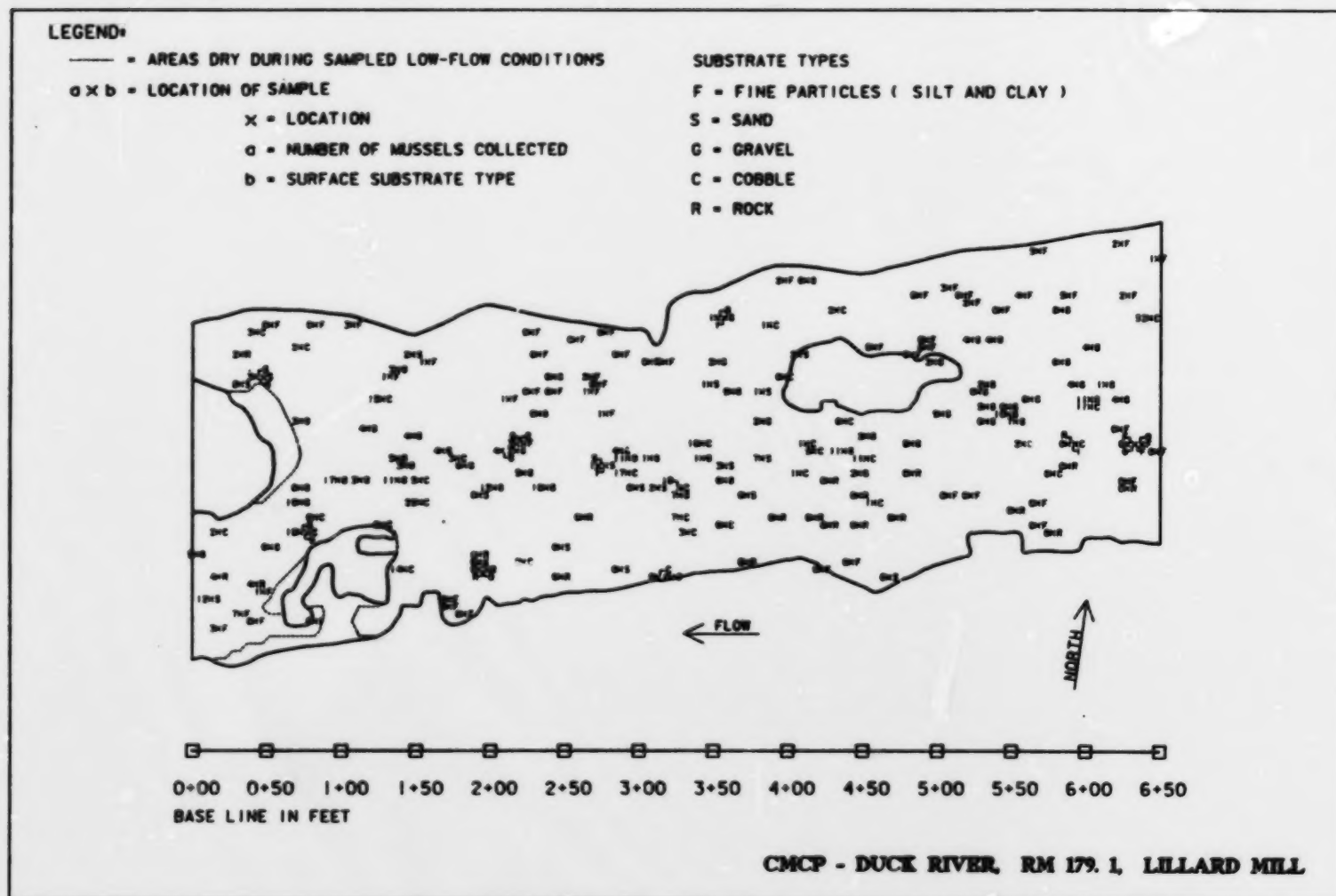


Figure A-5. Total mussels collected and substrate type (surface) at each sample cell location for study reach DRM 179.1.

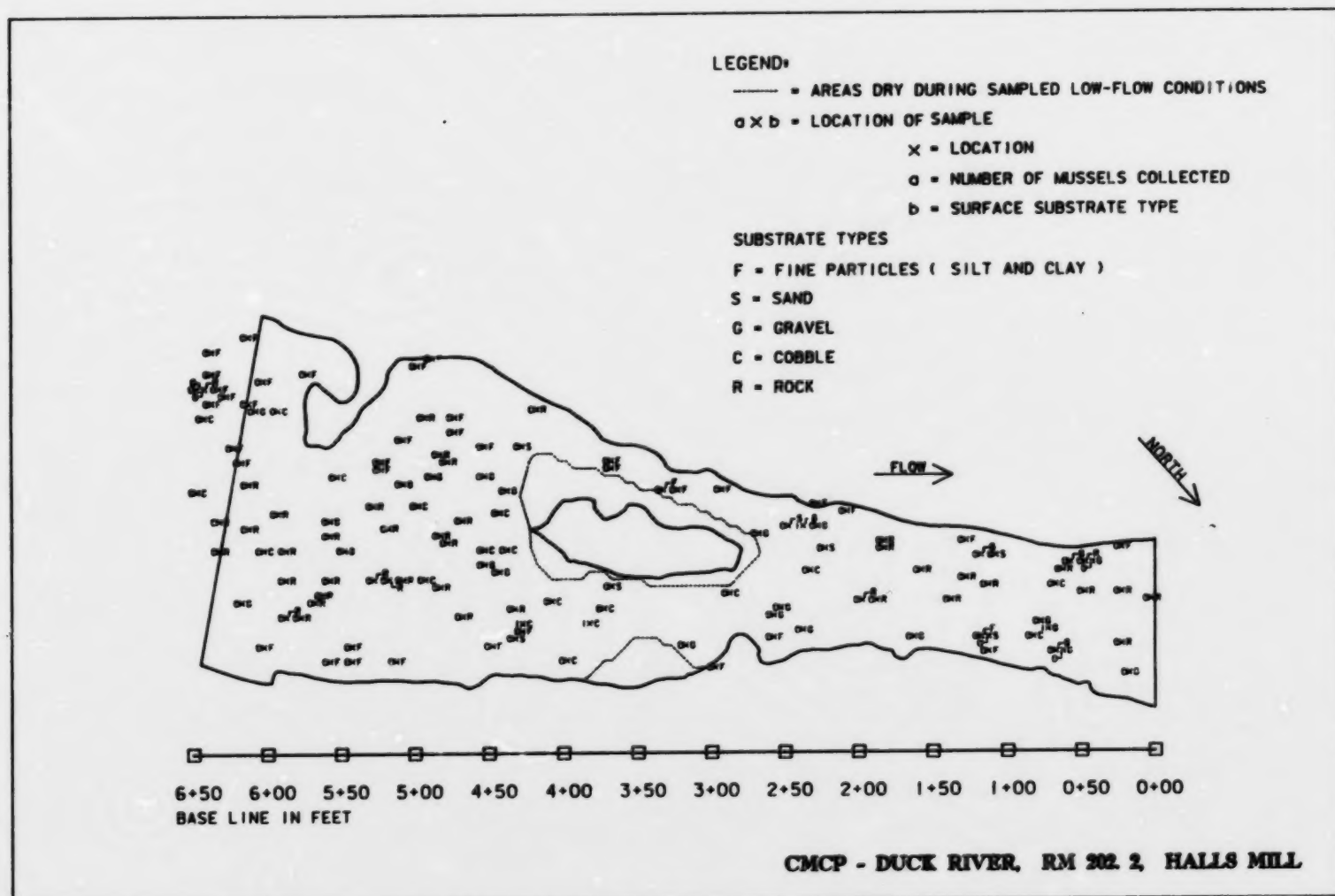


Figure A-6. Total mussels collected and substrate type (surface) at each sample cell location for study reach DRM 202.2.

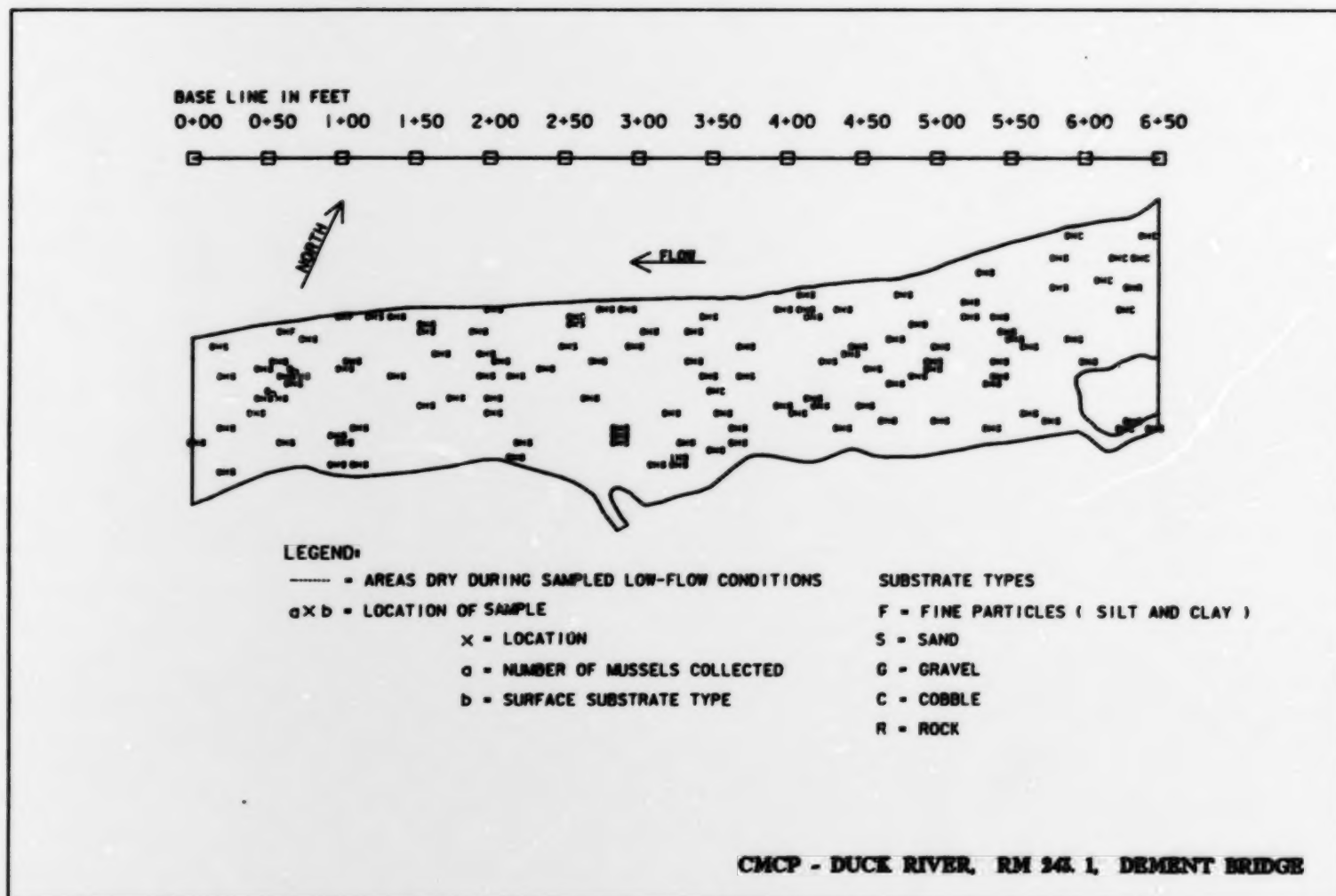


Figure A-7. Total mussels collected and substrate type (surface) at each sample cell location for study reach DRM 243.1.

LEGEND:

— = AREAS DRY DURING SAMPLED LOW-FLOW CONDITIONS

a x b = LOCATION OF SAMPLE

x = LOCATION

a = NUMBER OF MUSSELS COLLECTED

b = SURFACE SUBSTRATE TYPE

SUBSTRATE TYPES

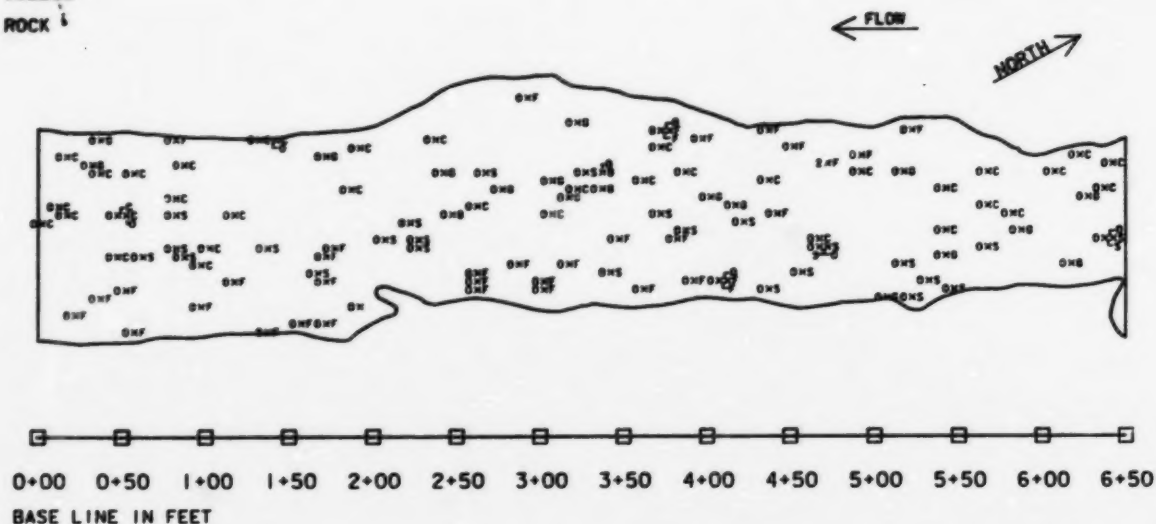
F = FINE PARTICLES (SILT AND CLAY)

S = SAND

G = GRAVEL

C = COBBLE

R = ROCK



CMCP - BUFFALO RIVER, RM 79.9, TOPSY BRIDGE

Figure A-8. Total mussels collected and substrate type (surface) at each sample cell location for study reach BRM 79.9.

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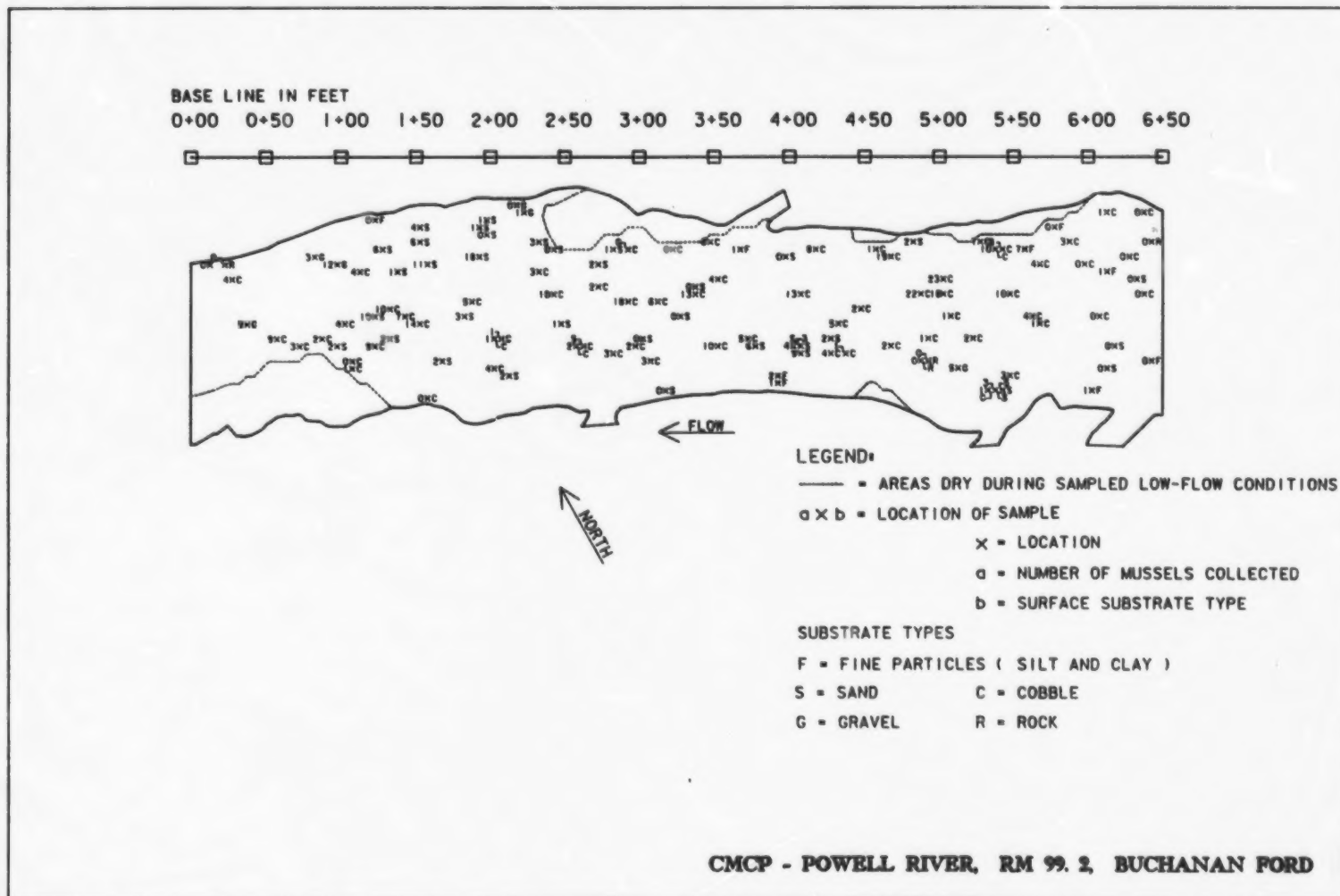


Figure A-9. Total mussels collected and substrate type (surface) at each sample cell location for study reach PRM 99.2.

LEGEND:

----- ■ AREAS DRY DURING SAMPLED LOW-FLOW CONDITIONS

a x b = LOCATION OF SAMPLE

X = LOCATION

Q = NUMBER OF MUSSELS COLLECTED

b - SURFACE SUBSTRATE TYPE

SUBSTRATE TYPES

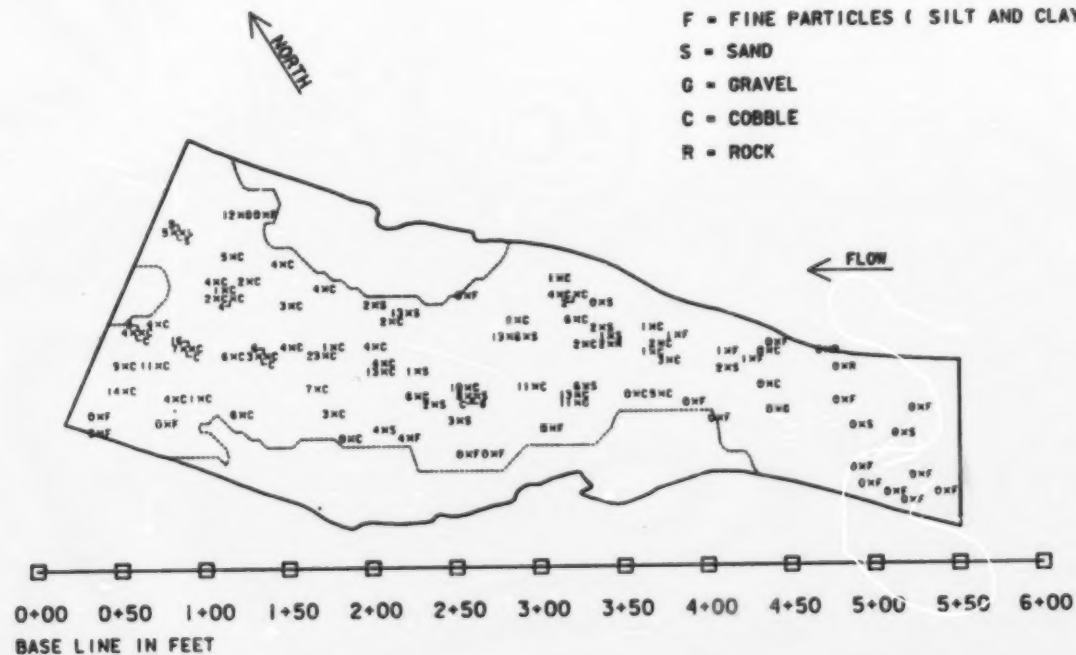
F = FINE PARTICLES (SILT AND CLAY)

S = SAND

G - GRAVEL

C - COBBLE

R - ROCK



CMCP - POWELL RIVER, RM 117. 4, FLETCHER FORD

Figure A-10. Total mussels collected and substrate type (surface) at each sample cell location for study reach PRM 117.4.

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LEGEND:

----- = AREAS DRY DURING SAMPLED LOW-FLOW CONDITIONS

a x b = LOCATION OF SAMPLE

x = LOCATION

a = NUMBER OF MUSSELS COLLECTED

b = SURFACE SUBSTRATE TYPE

SUBSTRATE TYPES

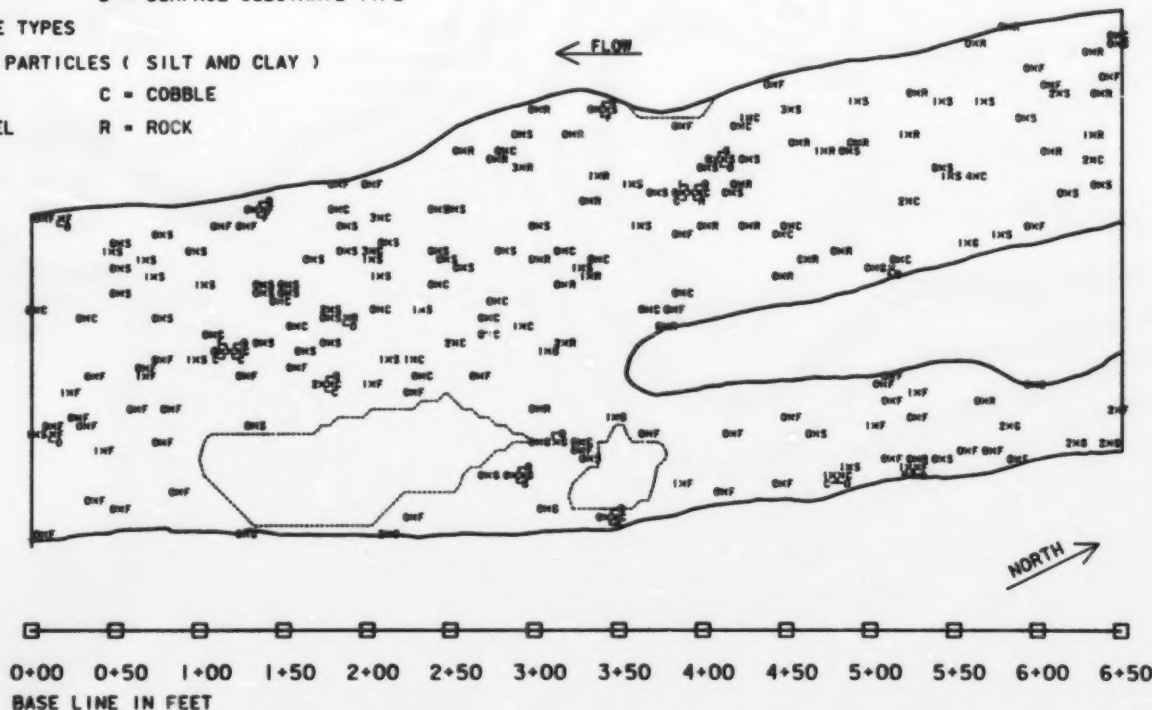
F = FINE PARTICLES (SILT AND CLAY)

S = SAND

C = COBBLE

G = GRAVEL

R = ROCK



CMCP - NORTH FORK HOLSTON RIVER, RM 6.2, CLICK ISLAND

Figure A-11. Total mussels collected and substrate type (surface) at each sample cell location for study reach NFHRM 6.2.

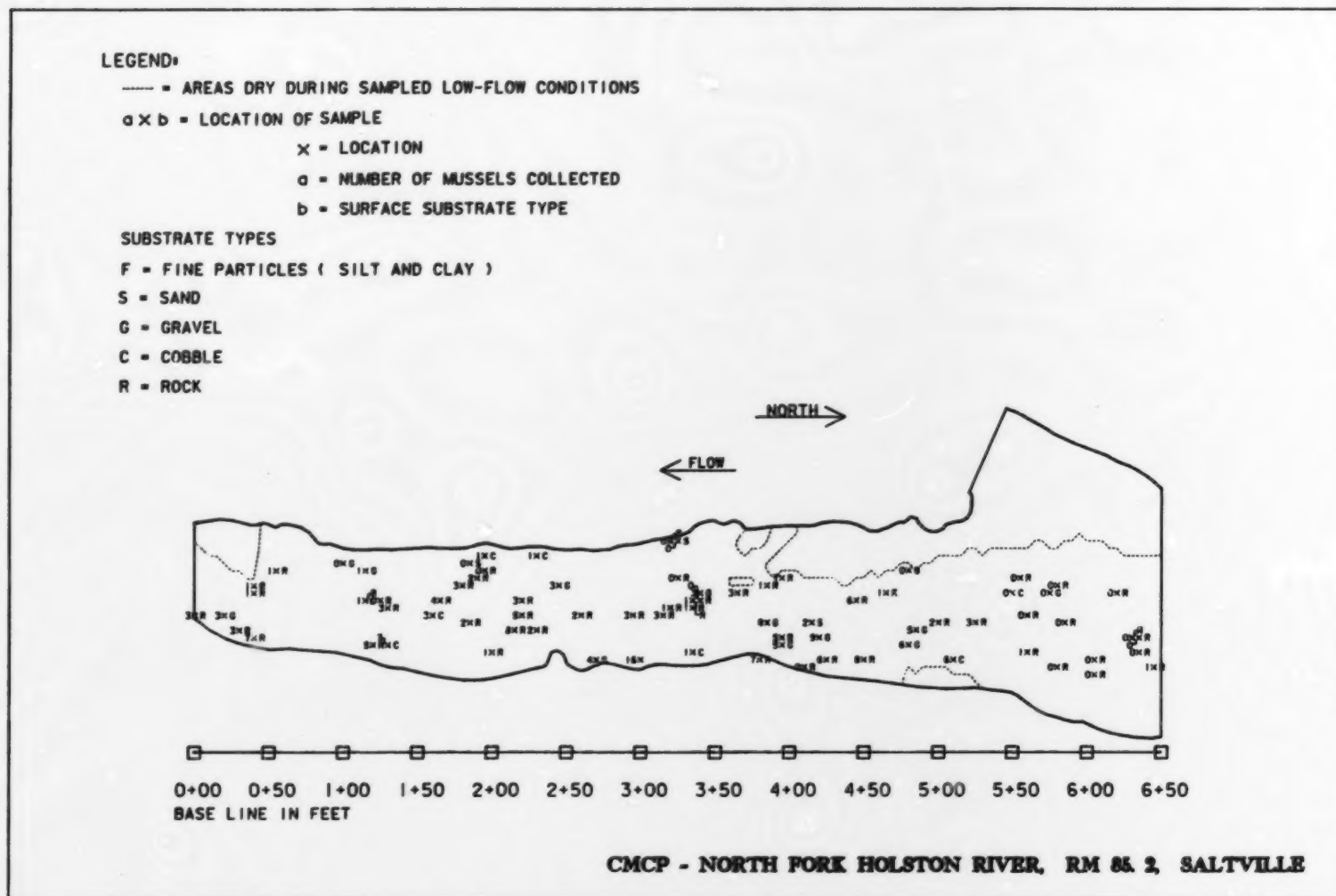


Figure A-12. Total mussels collected and substrate type (surface) at each sample cell location for study reach NFHRM 85.2.

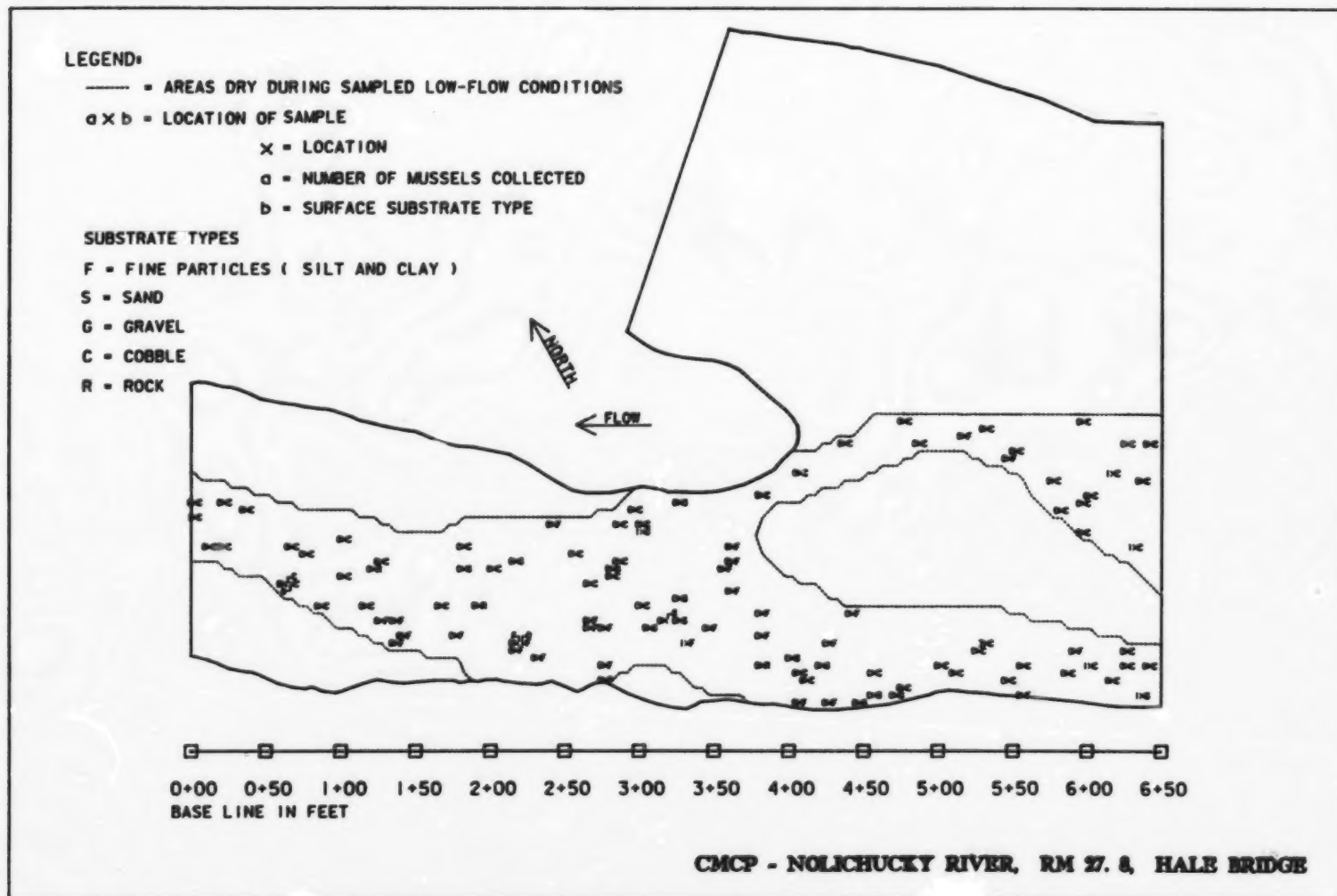


Figure A-13. Total mussels collected and substrate type (surface) at sample cell location for study reach NRM 27.8.

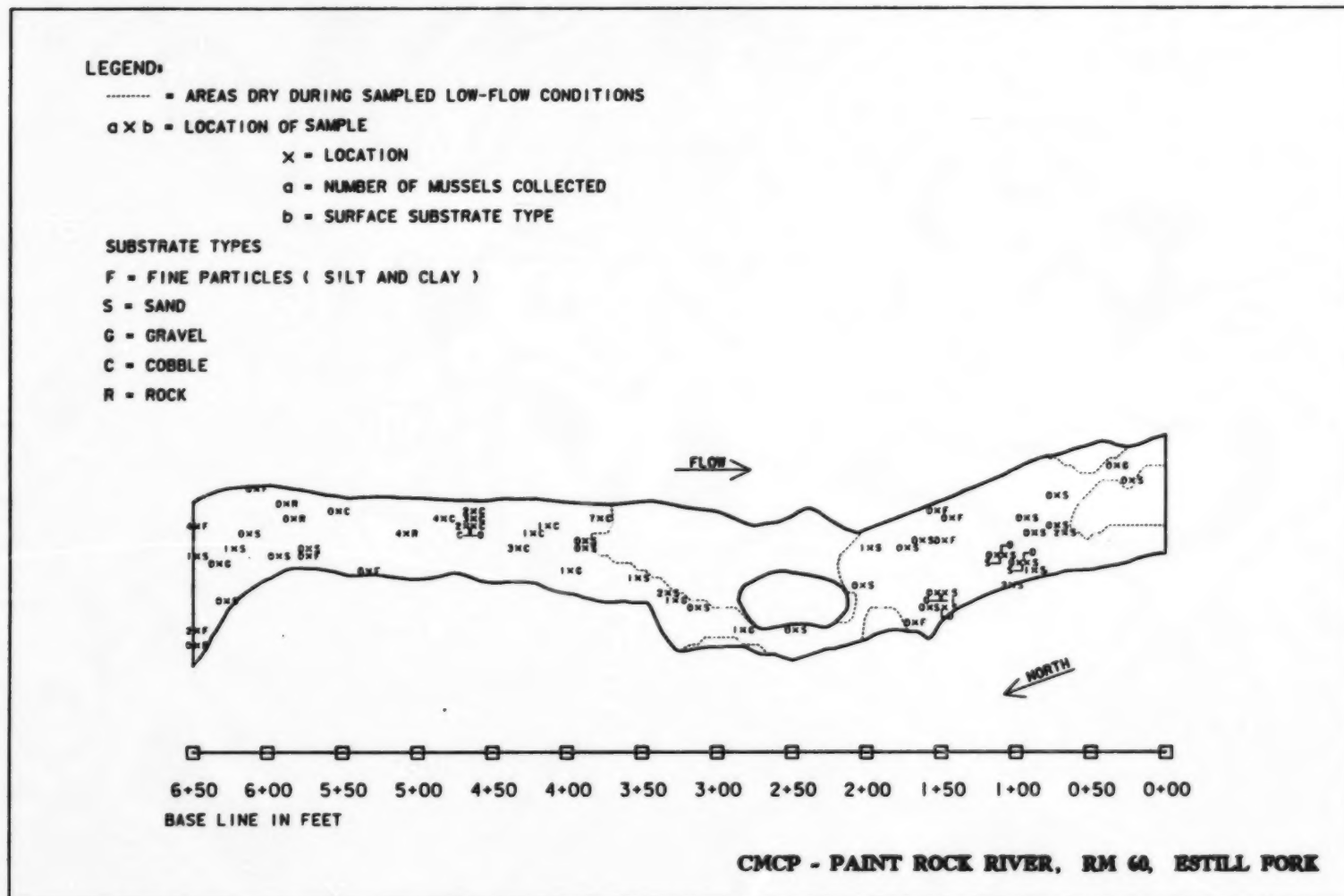


Figure A-14. Total mussels collected and substrate type (surface) at each sample cell location for study reach PRRM 60.0.

LEGEND:

— • AREAS DRY DURING SAMPLED LOW-FLOW CONDITIONS

a x b = LOCATION OF SAMPLE

X = LOCATION

a = NUMBER OF MUSSELS COLLECTED

b = SURFACE SUBSTRATE TYPE

SUBSTRATE TYPES

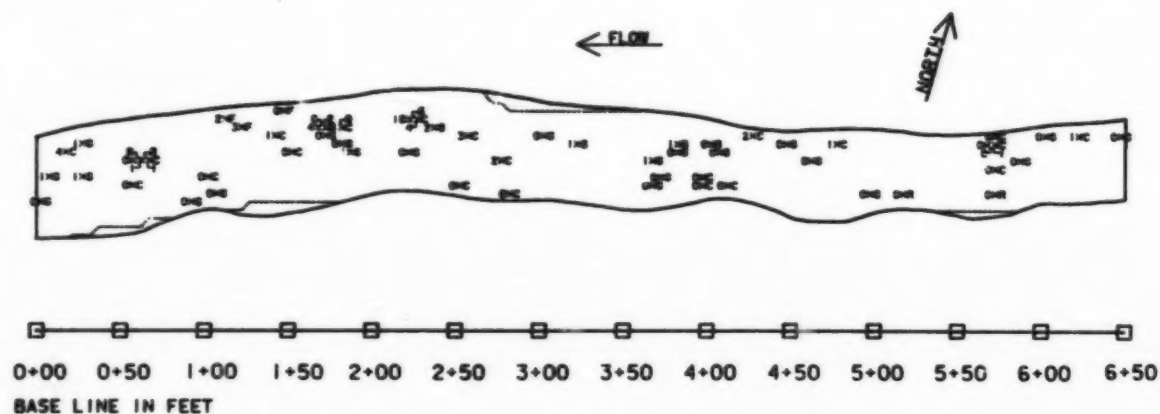
F = FINE PARTICLES (SILT AND CLAY)

S = SAND

G - GRAVEL

C - COBBLE

R = ROCK



CMCP - COPPER CREEK, RM 1 9

Figure A-15. Mussels collected and substrate type (surface) at each sample cell location for study reach CCRM 1.9.